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An illustrated magazine devoted to the advancement of natural history, the recording of scientific research, exploration, and discovery, and the development of museum exhibition and museum influence in education. Contributors are men eminent in these fields, including the scientific staff and members of the American Museum, as well as writers connected with other institutions, explorers, and investigators in the several branches of natural history.

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THE SEA ROVERS

Fig. 1.—A school of sharks, led by a twelve-foot tiger shark, are attacking a sea turtle. On the left is a large hammer-headed shark and in the background a huge man-eater. Sketched from the group in the American Museum by F. L. Jaques

NATURAL HISTORY

Volume XXVIII, No. I
January–February

FISH NUMBER

E. W. GUDGER
Editor

A Tour of the New Hall of Fishes

By WILLIAM K. GREGORY
Curator of Ichthyology, American Museum

The Fish Hall of the American Museum is now in process of preparation. Within a few months it will be thrown open to the public, and at that time the visitor will be able to see for himself the exhibits described by Doctor Gregory in the following "guide" to the Hall.—The Editors.

SWAYING and darting in a sunlit mountain brook, a live trout is resplendent in rainbow colors and streamline form. The same trout stuffed and mounted is often a stiff and grimy souvenir of death. And when we have to fill a whole museum hall with dead fishes and plaster casts of dead fishes, can any Ezekiel of the taxidermists' guild bring such dry bones to life? Such might well be the thoughts of the seasoned museum visitor as he approaches our portals. But, once he is lured inside our hall by the gleaming legend Fishes of the World, our cue is to give him no further time for doubts or for odious comparisons of our exhibits with those of the institution in Battery Park. We plan, figuratively speaking, to open our performance with a "crash," and hope to keep our visitor fascinated with the wonders of the fish world on the trip around the hall. But, lest he sink into apathy from overstimulation, we plan also to revive him at intervals with quiet scenes and large spaces of ocean blue and green.

William Beebe maintains, from a wealth of personal experience and investigation, that the reputation of sharks for ferocity is largely overrated. The late Carl Akeley affirmed the same of the gorilla, and even primitive man, both ancient and modern, has his champions. But, while honoring these humane and generous sentiments, we submit that, at least in the case of the tiger shark, the circumstantial evidence suggests that this pirate of the seas does not always wait, like the hyæna, for someone else to do his killing. At any rate, we felt warranted, after considerable inquiry, in pushing forward the installation of our large shark group at the south end of the hall. This is an underwater view entitled "The Sea Rovers," into which the department of preparation, under the able direction of Mr. James L. Clark, is putting some brilliant scenic effects. In the lower right quarter of the scene a large sea turtle is flapping his way in desperate haste and looking as distressed and apprehensive as a sea turtle well can. Swooping down upon him from the upper left hand corner is a converging pack of sea hounds, led by a large tiger shark, all hot on the scent. In the distance we see somewhat dimly a huge form that dwarfs the sharks of the foreground. It is the dreaded white shark or man-eater, and we can readily foresee that a few seconds later, when the water is a bloody maelstrom of lashing bodies, the giant will move up grandly, shoulder the lesser hounds away, and engulf the prize himself. In this group Mr. Clark and Mr. Jaques have achieved a masterpiece of great strength and simplicity.

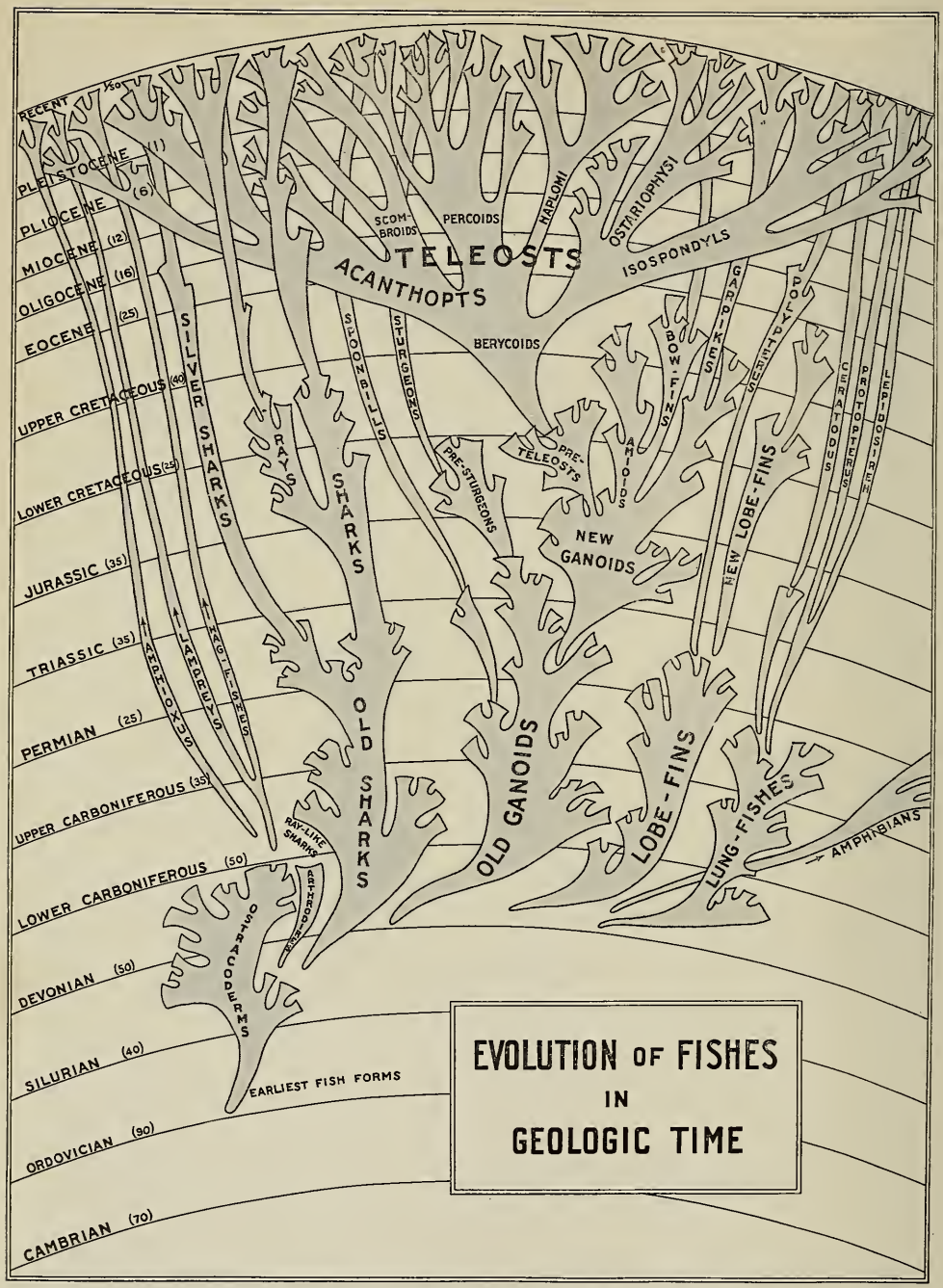


Fig. 2.—A "family tree" showing the genealogical history of the fishes

With the idea of sharks as living creatures thus awakened in his mind, the visitor may now perhaps be intrigued into looking on either side of the entrance at the two great wall cases which are full of lifelike models

and mounted specimens of sharks, big and little, ordinary and extraordinary. These sharks are not packed together in severely straight columns, like definitions in a dictionary, but are clustered in schools, as if swimming, upon a mottled bluish-green field that brings out all their streamline forms and low-visibility colors. In one wall case the central figure is the hammer-headed shark, a graceful form whose horizontally flattened head serves as a bow rudder and enables him to make surprisingly quick dives and turns in his pursuit of the swift bluefish. The center piece of the other large shark case is the stout-bodied thresher, which uses its amazingly long tail to round up the schools of small fish upon which it feeds.

If our visitor is now in the receptive mood for scientific knowledge, he may stop and look at the large decorative panel by Miss Isabel Cooper, entitled Evolution of Fishes in Geologic Time. Here the successive ages of the earth's history, as known to the geologists, form a background of zones arranged in ascending series, and upon these zones is depicted the "family tree" or genealogical history of fishes, so far as it has been inferred from a study of fossil fishes of past ages and from the evidence afforded by the comparative anatomy and development of existing forms. Gazing at this panel, the visitor may well be surprised at the literally inconceivable antiquity of the major subdivisions of the class or superclass of fishes, since as far back as the lower Devonian age (several hundred million years ago according to conservative recent estimates) the grand division that later gave rise to our modern sharks and rays was already well separated from other grand divisions, including the "Old Ganoids," the "Lobe-finned Ganoids," and the "Lung-fishes." He will also notice another main stem, coming out from between the lobe-finned ganoids and the lung-fishes and labelled "To Amphibians." This branch stands for those ardent though fishy beings who first dared to take their air straight, and to inhale its fiery essence directly into their lungs, without diluting it with frequent gulps of foul water. Adventurous pioneers they were, wriggling up from the mud flats, putting the fan-shaped paddles their ancestors had evolved to the new use of pushing the body along on terra firma, thereby making such good speed that they could capture the giant cockroaches and fat larvæ of huge dragon flies. They thus laid the foundations for the long line of tetrapodal pirates that culminated in *Homo sapiens*.

Absorbed in such pleasing reveries, our intelligent visitor will then look toward the center of the chart to that incomparably distinguished and aristocratic division designated "Old Ganoids," the F. F. V.'s of the ancient world. These were the victorious mail-clad knights of old Devonian days who supplied the *vis a tergo*, the pressure from the rear, that drove our own ancestors out of the water. Even before that time the Old Ganoids, like true pioneers of a strenuous race, had nearly exterminated the aboriginal inhabitants, the lowly Ostracoderms—grovelling creatures—which were Nature's first attempts to evolve a fish.

Spreading into and subduing all the inland waters, the Old Ganoids, like the Mongol invaders of Europe, gradually deployed into many hordes or divisions. The histories of these divisions, in so far as it has been unravelled by the patient researches of ichthyologists, afford many instructive parallels

with the histories of human dynasties and cultures. The members of each main division, branching off from the central stock at a given time and place, inherit from it a particular grade of organization and a special "culture" or way of life. What then shall they do with this inheritance, when they are set off by themselves, a new colony in some far-off place, where they are safe from the competition of their own kind, but have still to meet the competition of the present inhabitants and the unexpectedly severe climatic aberrations of a new environment? Fish and men respond to this situation in much the same way. Some races rapidly adapt themselves to the new conditions. Finding some favorable line of advance, they recklessly sacrifice their old equipment and old ways, force themselves into the new economic niche, and eventually become so highly specialized in its ways that they are fit for nothing else, or at best can meet new changes in the environment only by further specializations in the same general direction. In other words, starting in as conservatives, they skip the progressive stage and soon develop into radicals and freaks. Again and again many of the descendants of the Old Ganoids left the straight and narrow path of their ancestors, gave up the free life of buccaneers in the open waters, and slunk away to become mud-grubbers, like the sturgeons and carps and catfishes, or to take refuge in holes and crannies and become slinking ratlike pilferers, living like eels in foul waters. Not so the old guard, the saving remnant of the Old Ganoids. Yielding as slowly as possible to an insidious pacificism, they asked and gave no quarter, and age after age somehow managed to give rise not only to new hordes of more or less degenerate descendants, but to the true viking strain, that after millions of years finally flowered out in the highest of the Teleosts, the basses and the mackerels.

With such general ideas in mind our receptive visitor will now find meaning and inspiration in the legend

GANOID FISHES—LIVING FOSSILS

that dominates a series of groups, including the paddlefish, shovel-nosed sturgeon, gar pike, and bowfin. And he will readily see for himself how these relics of long bygone ages illustrate the general principles outlined above; how the paddlefish, retaining the sharklike body-form of the Old Gancids, has sacrificed the shining armor of his family and, scaleless, now preys upon helpless small creatures which it searches out with its marvelously sensitive paddle-shaped snout and engulfs in its capacious mouth; how the shovel-nosed sturgeon, a senile mud-grubber, grovels on the bottom and sucks in the reeking paste with its toothless lips; how the gar pike, a real old die-hard, proudly wears his shining armor of enamelled scales and, although too old for open warfare, still maintains the baronial right to make sudden forays upon the helpless caravans of fat-bodied carps.

Coming to the end of the Ganoid series, the visitor will inspect one of the most interesting of all the "missing links," one still alive, namely, the bowfin. Fortunately for himself, the bowfin has no particular value either to the epicure or to the angler, and ichthyologists are not numerous enough to make serious inroads upon his numbers. He is literally of a retiring disposition and ordinarily lies almost motionless, except for the slow waving of his elongate dorsal fin. The mounted

group, however, reveals the bow-fin in a livelier mood and portrays a scene of considerable dramatic interest. For it shows two of the nests, or oval depressions, that the bow-fin scoops out at the mating season; one of them occupied by a newly mated pair guarding the nest, the other by a lone male that seems to glower unpleasantly at the domestic felicity of his successful rival

Fig. 3.—The Bowfin Group.—This illustrates the nesting habits of this ganoid fish (*Amia calva*). On the left a pair of fish are spawning on a nest; at the right a male stands guard over the eggs. After Dean

At this point the visitor glances upward at another gleaming legend

TELEOST FISHES
Highest Types of Fish Life

and immediately enters a series of three-sided alcoves flanked by wall cases, along the east side of the hall. The series begins in a rather quiet way with the salmons, trouts, tarpons, herrings, and other descendants of the oldest families of the newer or teleost aristocracy. This alcove will (if a true Mæcenas of the Fish Hall ever materializes) be dominated by a mural painting on the wall above it, showing salmon leaping up the falls of a river on their long pilgrimage to the spawning grounds.

The next alcove sets forth the strange forms included in the order of Ostariophysi i e., fishes with a train of little bones connecting the air-bladder with the skull. Who would suspect that even the despised catfish, to say nothing of the lowly carps and suckers, would be endowed with such a marvelous and unique mechanism for transmitting sensory responses to slight differences in water pressure from the surface of the body to the organs of balance in the inner ear and brain? Or who would suspect from their appearance that the carps, with their protrusile toothless mouths, have an elaborate dental mechanism in their throats?

This alcove will some day (D. V.) be dominated by a mural showing a school of vicious little piranhas or man-eating fish attacking a floating mass that breaks the sunlight from above, while below several large black catfishes begin to move out from the mangrove roots in anticipation of the approaching feast.

The next three alcoves are devoted exclusively to the glorification of the latest and most beautiful models of the fish world—the basses, bluefishes, mackerels, crevallés, and their multitudinous relations. Among these families the history of the Old Ganoid stocks almost repeats itself. For here are the conservative types like the black basses, the progressive types like the bluefish and the mackerels, and numerous radicals and freaks, which fill the remaining alcoves and wall cases of the Teleost series.

The central forms, typified by the perch and the striped bass, inherit a peculiar assemblage of characters which crop out, in whole or in part, and beneath endless modifications in detail, in perhaps ninety per cent of all the species of fishes living today. As far back as Cretaceous times during the closing æons of the age of reptiles, the ancestors of the spiny-finned fishes appear for the first time in the known fossil record. Curious, short, deep-bodied forms they were, with their hind limbs (including the pelvic girdle and the ventral fins) firmly fastened to the lower part of their collar bones (or pectoral girdle). This swivel-chairlike arrangement, which is seen at its best today among the quick-dodging inshore fishes, is only one of numerous meritorious features that have enabled the spiny-finned forms to crowd nearly all the older types into out-of-the-way corners of the fishy world.

As to the future murals, which will form indispensable centerpieces on the walls above these alcoves, the one above the first spiny-finned series will depict the golden grouper of the Galapagos islands, gleaming amid the dark volcanic rocks and surrounded by his retinue of olive-green relatives. That on the wall above the wrasses and their allies will reveal one of the large and gorgeous parrot-fishes winging and steering his way among fantastic coral growths and accompanied by butterfly-fishes and Moorish idols, while the mural on the wall above the mackerels and their allies will represent a school of swift bonitos leaping and plunging like dolphins into the waves.

The last alcove on the east side of the hall is devoted to the most highly specialized and strangest of all the families of the spiny-finned order of Teleosts. The panel of the trigger-fishes will be surmounted by a mural showing the Bermuda file-fish—a spotted, kite-shaped thing with length and height but hardly any thickness, cheeks prolonged excessively downward and forward, a fixed stare and an impossibly small and scornfully upturned mouth.

But the prize exhibit of this alcove is the life-size model of a relatively gigantic sea devil, *Ceratias holboelli*, the original of which is in the British Museum of Natural History. As described by Dr. Tate Regan, this particular specimen was a female with a curious appendage attached to her throat, which upon close inspection proved to be nothing more nor less than a diminutive male of the same species, fully adult and apparently the mate of the giant female. The explanation offered by ichthyologists for this strange state, approaching semiparasitism on the part of the male, is that it is Nature's way of insuring the perpetuation of the

species, since, before this happy solution of the problem, the chances of lone wandering female sea-devils finding mates in the vast black spaces of the great deep were slim enough. But what the ichthyologists have not explained is how or why such a meek and inoffensive little male fish should ever become ambitious and rash enough to press his unwelcome attentions upon a giantess of such frigid and austere mien. In the present undeveloped state of psychoanalysis as applied to ichthyology, our own simple and direct hypothesis, submitted here for what it is worth, is that after the affair was fairly started, the rash little male had a very narrow escape from the cavernous jaws of his all-devouring bride, and that to save himself in one of her tantrums he caught her by the throat as she rushed at him; and being too much terrified to let go, has been there ever since.

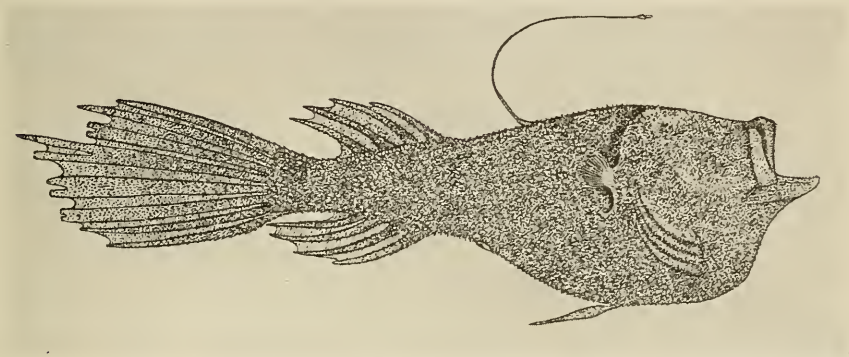


Fig. 4.—A female sea-devil (*Ceratias holboelli*) with the dependent, permanently attached, parasitic male fish. After Regan

A few steps more and the visitor will be facing the climax of the whole exhibition, the Sailfish Group, which is the centerpiece of the collection of Big Game Fishes. (For a reproduction of this in colors, see the cover of this issue of Natural History.) In the background the precipitous rocky islets of Cape San Lucas jut into the splendor of a southern California sky and tower above a choppy sea where ocean currents struggle. In the foreground a nine-foot sailfish is hurling his lithe body clear of the water. The sunlight flashes from his dripping flanks and purple sail, as in frantic rage he twists and shakes himself. But the cruel hook in his jaws holds fast and the thin line leads back to the boat near by, where the human partner in the duel pits his quick hand and unflinching will against the plunging weight of the maddened fish. We trust that when Mr. and Mrs. Keith Spalding of Pasadena, California, view this group it will bring back very vividly to their minds the scene when the fish was caught by their guest, Mrs. Addie C. Greenfield, on their yacht the "Goodwill" in June, 1925 It was due to their hospitality that Mr. Walter Escherich of the Museum's department of preparation was present on that occasion, and was enabled to secure full color notes, casts, exact measurements, and a properly prepared skin as a basis for his highly lifelike mount of the fish itself. And it was due largely to their further interest and generosity that the striking background was painted by Mr. Frank J. MacKenzie.

The whole north wall of the hall is

NEPTUNE'S FIREFLIES

In the open seas of the Atlantic and Pacific incredible numbers of small lantern fishes (*Myctophum coccoi*) live in the daytime at considerable depths, but come up to the surface at night, and may be caught in fine-meshed tow nets. Rows of phosphorescent spots appear on the sides and on the head. The lights enable the schools of fish to keep together and serve to attract the swarms of minute shrimps upon which the fish feed. The lights are also used as lures by larger fish to attract the smaller kinds. *Astronesthes*, the fierce enemy of the Myctophids, follows them in their nightly journey from the depths and drives them furiously before him

Figs. 5 and 6

BLAZING JEWELS

The silver jewel fish (*Argyropelecus*) lives far down where the last feeble light from the surface merges into the blackness of the ocean depths. Like grand court dames arrayed for a royal fête, these pompous little creatures wear their silver robes and flash their dazzling jewels. Foolish shrimps, attracted by this display, crowd nearer, while the sly jewel fish, with bulging eyes turned loftily upward, moves up quietly below the shrimp and suddenly engulfs it

hung with fishes that are far bigger even than those that get away from most fishermen. The gigantic ocean sunfish, the huge tunas, marlins, and swordfishes, and all the others are the hard won trophies of Mr. Zane Grey, the well-known author and Nimrod of the Seas, to whom the Museum and the Museum public are indebted for this splendid collection, which is described in a special article (page 93).

Adjoining the Zane Grey collection are several other cases containing some fine examples of fresh-water and surf fishes presented by Mr. S. W. Eccles, the late Jacob Wertheim, and others. Mr. Van Campen Heilner, the field representative in charge of the Game Fish collections, plans to install near by a bulletin board containing a current list of "Record Fishes." Mr. E. R. Hewitt is developing an exhibit illustrating the history of fly fishing in England and America which he has presented for the Game Fish Collection. It is hoped that other donors will

Fig. 7

THE DRAGON STRIKES
The black night of the ocean depths cannot hide the peaceful big-heads (*Melamphaes*) from their cruel enemy the dragon-like *Chauliodus*. While they are wandering in the vast spaces he draws near. Now he strikes—but misses them in the wild confusion of flight

Fig. 8

LITTLE SEA DEVILS
The mediæval imagination never pictured imps of darkness half so grotesque as these. But despite their terrifying exterior the little sea devils are no worse than human fishermen who attract fish with a light and scoop them into a trap. Only in this case the light is a bit of luminous skin dangled on a slender bony rod held over the trap, and the trap is the little sea devil's enormous mouth set all around with needle-like teeth

come forward with early copies of Isaac Walton or other classics for our future exhibit on the history of game fishing from the days of the cave men to modern times.

Turning now to the west side of the hall, our visitor comes to the biologic exhibit, which is installed in two long wall cases. In the first of these, when it is completed, he will find a series of enlarged models illustrating the embryonic development of various kinds of fishes, based largely upon the materials and observations of Professor Bashford Dean, the first curator of the department, now honorary curator. In the Port Jackson shark, a "living fossil," the last survivor of an ancient

group of sharks, most of which died out in the Age of Reptiles, the development of the embryo is extremely slow, requiring probably not less than seven or eight months. Here the eggs laid in any one season are very few, but each is endowed with a huge mass of low-grade capital in the form of sacrificed in millions to the rapacity of other animals.

A second panel of this exhibit will deal with parental care among fishes, illustrating the subjects of nests and nest building, the care of the young in brood-pouches, and the self-denying behavior of certain catfishes, which (as

Fig. 9.

BLACK PIRATES

These deep-sea pirates are not snakes but "degraded eels," that have lost almost everything but their voracious appetites. One of them has just swallowed a fish that is bigger than himself, which stretches him nearly to his elastic limit. His less fortunate mate, yawning fearfully, opens the dark gateway to his cavernous interior

yolk. When the young shark is finally ready to break through the shell, it is almost like a small edition of its parents and is ready to carry on life in almost the same way. At the other extreme, in some of the higher teleosts, the capital endowment is spread over several hundred thousand minute eggs, which develop very rapidly into tiny larvæ quite unlike their parents, and feeding upon entirely different food. Thus, while the well endowed patrician shark-young are fed from the capital left by their parents, the swarming proletarian teleost larvæ must earn their own living from infancy and must be vouched for by our own Doctor Gudger) zealously guard the eggs while holding them in their mouths during the entire period of incubation.

The third and fourth panel will show the amazingly diverse mechanisms of the jaws and teeth of fishes together with the crushing and grinding apparatus that some fishes carry in their throats. The fifth and last panel in this case will show the different forms of the digestive tract in flesh-eating and herbivorous fishes.

In the second wall case of this biologic series the visitor will note in the center an array of fishes of widely

different body forms, that range from the excessively elongate snipe-eel to the very short but high Moorish idol, and from the extremely wide, flat angler-fish to the extraordinarily thin moon-fish. In the next panel he will see how a long-bodied fish slips through the water by waving its whole body like a flag in the wind; how the skates use this same principle in flapping their wings; how the short, stiff-bodied trunk-fish wags along by means of its tail; and how such a normal bodied fish as a crevallé stands midway in its method of locomotion between the eel and the trunk-fish. Here also the visitor will see the mechanical models with which Mr. C. M. Breder, Jr., of the New York Aquarium, who is also a research associate in this department, has been able to reproduce the principal body movements of fishes. From all this, the visitor will readily comprehend how easily an eel, with its long, low head and snakelike body, slips through the water, and why the opposite combination of characters, short, very high body. steep forehead and wide-spreading pectorals, combined with small nipper-like jaws is favored by fishes that require a firm stance to pluck their food from the solid reefs.

Another panel of this case will, when completed show how the most diverse body-forms of fishes conform to streamline curves that offer a minimum resistance either to currents or to forward locomotion. Here also the visitor may learn in how far fishes and ships are built on the same principles and in what others they differ radically.

From the biologic exhibit the visitor may enter the large inner room that contains some of the most noteworthy of the mounted groups. The future centerpiece of this room will be a scene of tropical fishes, probably the reef fishes of Hawaii. Moorish idols, like high, flexible triangles, with broad vertical bands of black and yellow, and long wisps trailing from the upper and lower corners, will float unconcernedly above a great open-jawed serpent-like moray, spotted like a harlequin and writhing horribly. Fatuous looking trigger-fishes of impossible color combinations will be bustling around, their faces smugly complacent, like libellous caricatures of obese statesmen. Bejewelled parrot wrasses will flaunt their gaudy array like revellers in a pagan festival, while the silvery carangoids, spiralling down from the blue above, will look with appraising eyes, searching for their victims among this riot of mad colors and wild forms.

The next group will offer a wide contrast to this for it will be a study in dark colors and grays, with the somber battlements of submerged volcanic rocks in the Galapagos Islands for a background. Behind a narrow cañon between two great rock masses pale shafts of light stream down, lighting the rear guard of an army in motion. Forward through the gap and into the open, it winds its way, a drifting Milky Way of winged hosts of drab and frowning *Xesuri*,[1] waving their yellow tails like banners. Just one scene in a crowded day under water, but a scene that will not cease to haunt us until we can bring it to life again in the Hall of Fishes.

In this large inner room there is hung a series of color drawings of deep-sea fishes collected by the "Arcturus" expedition, with some of the original specimens mounted in square glass jars. Near by are enlarged photographs of deep-sea dredging machinery in operation on the "Arcturus." For all

[1] For a colored figure of *Xesurus* and a lively account of its behavior, see William Beebe "The Arcturus Adventure," New York, 1926, chap. XI, pl. VI.

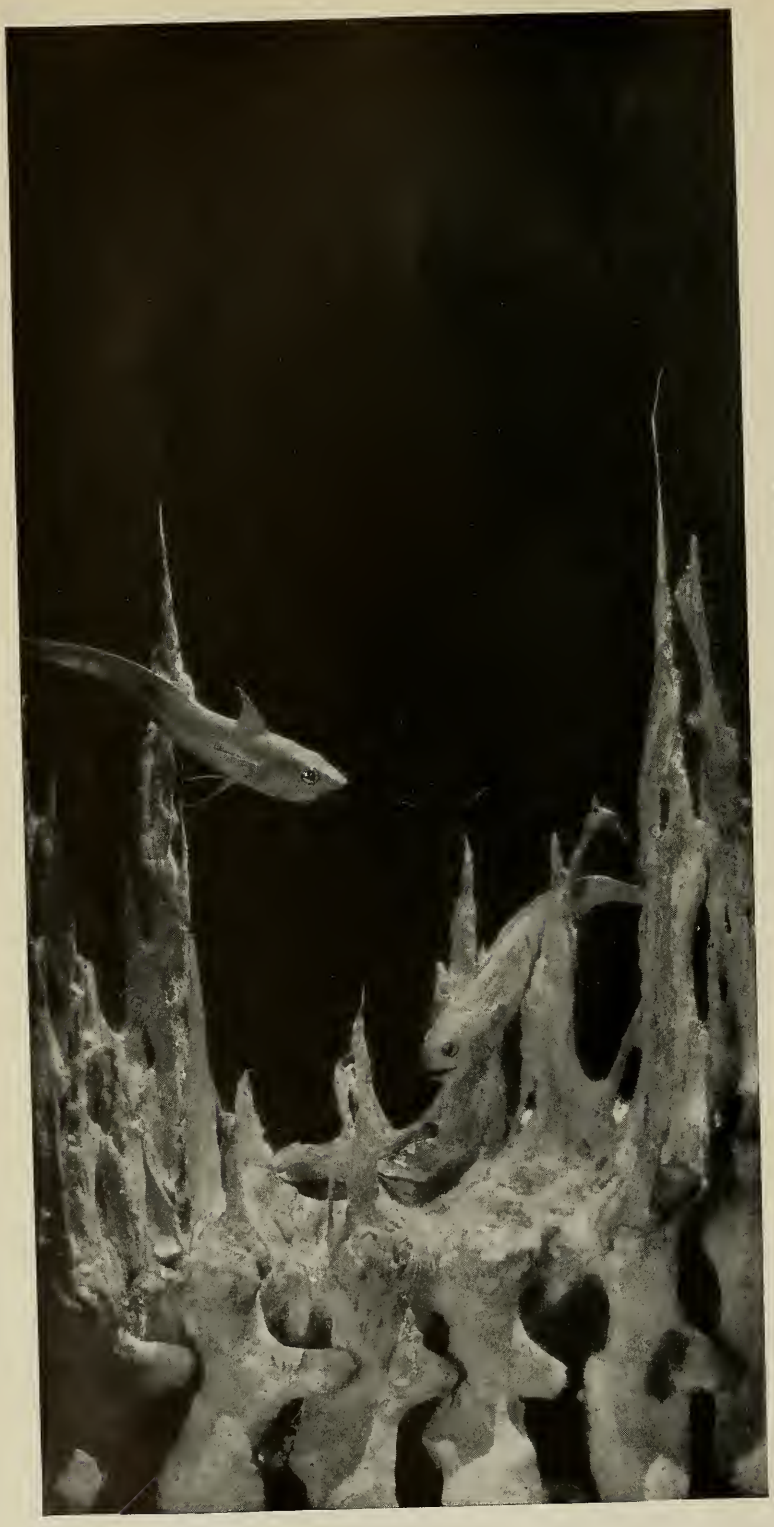


Fig. 10

WANDERING GHOSTS

Like some long forgotten wreck the carcass of a great whale lies sprawling on the ocean floor, and like famished ghosts of shipwrecked sailors the pallid ratfishes wander to and fro amid the wreckage.

Figs. 5–11 are reproductions of the seven panels of Deep Sea Fishes in the darkened chamber occupying the northern end of the central inclosure in the Hall of Fishes. The seven groups represent, from left to right, a descending series of zones of fish life, and end with two panels showing fishes swimming around the skeleton of a whale on the ocean floor a thousand fathoms deep in the Country of Perpetual Night. The legends given under the seven figures are the labels which the visitors will find under the respective groups

Fig. 11

THE COUNTRY OF PERPETUAL NIGHT

The Country of Perpetual Night lies at the bottom of the ocean a thousand fathoms deep. Its inhabitants are hobgoblins, fearsome shapes that writhe and dart in and out in the midst of a fantastic Garden of Death. Gleaming serpent forms, blind creatures that crawl and grope in the darkness, black living masses, horrible and cold to the touch, they look at first like evil spirits condemned by some wicked magician to live in this desolate purgatory. But when Science holds up for us her crystal lens, the scene loses its terrors, and we see each quaint hobgoblin as it really is—a miracle of design—fitted to live in the midst of inconceivable pressure and able to find its own mate in the loneliness of Perpetual Night

this we are indebted to the New York Zoological Society and the unfailing interest of Mr. William Beebe.

In the center of the "Arcturus" exhibit a doorway leads to the groups of Deep Sea Fishes designed and modeled by Dwight Franklin. This beautiful exhibit is arranged in seven panels and represents from left to right a descending series of zones of fish life. The original materials and data for these groups were for the most part collected by the "Arcturus" expedition in the Pacific Ocean in the neighborhood of the Galapagos Islands Since deep-sea fishes are as a rule excessively flimsy in structure, it is not practicable to make satisfactory mounted skins of them for a group so that we have used very accurate models colored from the paintings made by the artist of the "Arcturus," when the specimens were either still alive or but very recently dead. On that memorable voyage special efforts were made to study as many as possible of the light-bearing fishes when alive; and in the photographic dark room and laboratory of the vessel many observations were made on the appearance of living fishes from considerable depths, that have been utilized in the planning and preparation of the present museum groups. Our first care has been to convey some sense of the vast and utter blackness of the environment in which these curious creatures live, and our visitor will probably feel that in this Mr. Franklin has been highly successful. Our second difficulty was to find fishes that were large enough to be easily seen without a magnifying glass, for, out of the many thousands of deep-sea fishes dredged by the "Arcturus," extremely few were longer than one's little finger. This is possibly due in part to the fact that, because of the low temperatures and the darkness in which these fish live, the rate of growth from the minute fertilized egg to the fully adult stage is exceedingly slow, and most fishes get eaten up long before they can attain the large size of such great rarities as the fifty-four inch "gulper" described by Harwood in 1827, which we have chosen to model for the centerpiece of the entire series.

The seven panel-groups of deep-sea fishes above referred to are shown herein as Figs. 5 to 11, from photographs by Messrs. Rice and Dutcher of the Museum staff.

The discerning visitor will realize that we have of course spared no pains to make our groups accurate as to essential facts; also that in our labels we have endeavored to divest the subject of its technical aspects and to present it to the public in language and symbols that will stimulate human interest in the lives and tragedies of the dark underworld of the ocean depths. For those who may be interested in the broader and more scientific aspects of the subject the following label is provided:

DEEP-SEA FISHES

Fishes that live at great depths have to be able to endure enormous water pressure, low temperatures (near the freezing point), and total darkness. At one mile depth each square inch of surface of a fish's body is under a pressure equal to the weight of a column of water a mile high and with a base one inch square. But the pressure is equal in all directions. It permeates the whole fish both inside and outside and evidently does not injure the most delicate tissues.

Deep-sea Fishes have been derived from the most widely different kinds of shallow-water fishes and differ almost as much as these do in appearance and form of body; but many deep-sea fishes are flimsy in build and more or less eel-like with pointed tails. The vast majority are quite small, because

food is scarce and growth in the intense cold is very slow.

All deep-sea life is dependent ultimately upon the rain of food-bearing particles from the richer waters of the surface. The countless myriads of microscopic plants are absorbed by the microscopic animals, and these by the billions of tiny copepods and shrimps which in turn are devoured by the ravenous small fishes.

Many different kinds of deep-sea animals have the power of making a phosphorescent light. Among the fishes, the surface of the body is often studded with little glow lamps. Each tiny lamp has a lens, a reflector, and a gland for producing a substance called luciferin which emits a light when supplied with oxygen from the blood. The little shrimps and other creatures upon which the fish feeds are attracted toward the lights as the moth is to the flame. The lights also enable fishes of the same kind to find each other and keep together in schools.

The departing visitor will probably linger a while longer, examining the remarkable series of water-color paintings of the strange fishes that were collected by Mr. William K. Vanderbilt during a recent cruise to the Bahamas and Galapagos Islands. The fishes were painted while still fresh by Mr. William E. Belanske. These pictures, which have been presented by Mr. Vanderbilt, are mounted on screens on either side of the main entrance.

In the light of all he has seen today, our visitor will no doubt enjoy the beauty and truth of the following illuminated verses, which were composed especially for our Fish Hall by poets who are distinguished for their ability to sense and to make audible the subtle harmonies of the ocean.

UNDERSEA

This so-called dark and silent undersea,
What if its colors throw off sound and song?
What if this seaweed's waving forestry,
These buoyant folk that swim the depth along,
Were choral as the birds among their branches?
And if these burnished scales that specialize
Past sight and sound in their unfathomed ranches
Find wonder that eludes our ears and eyes?
What if this sea were rhythmic with a story,
Not earth's, but only differing in glory?

ISABEL FISKE CONANT

They move and have their being in the vast
Ocean that teemed before the land was green;
They keep the secret of the farthest past;
Children of water, silent and serene.

SARA TEASDALE

The Habits and Life History of *Lophius*, the Angler Fish

By ULRIC DAHLGREN

Professor of Biology, Princeton University

AMONG the several groups of highly modified fishes which have, in the ages, developed from some branches of the fish family tree, none is of higher interest or of more decided specialization than the order *Pediculati* or angler fishes. Certain technical features, nearly always present, and certain other general ones may serve to define this group.

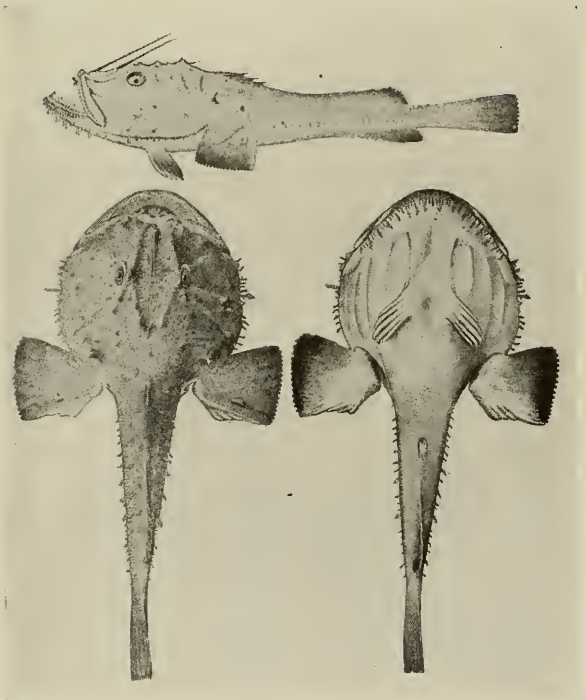


Fig. 1.—The American angler or fishing frog, *Lophius americanus*, in side, top, and bottom views. After Goode and Bean, Oceanic Ichthyology, 1895

The first of these technical features is indicated by the Latin name *Pediculati* which was given to the group because the pectoral fins, which correspond to a man's arms, a bird's wings, or a dog's front feet, do not emerge from the body directly as in most fishes, but the base has grown out into a fleshy *pedicle* that is analogous, and also in a measure homologous to our arm—a short arm, but one by which the fish can be seized and lifted from the water, or around which a rope may be tied to "anchor" the creature to a dock or a stake. The bony and muscular elements of this pedicle or arm are present in most other fishes but do not show usually and sometimes appear to be entirely absent.

The second feature (usually present in the various members of the order) is a modification of the first dorsal fin in which the posterior fin rays have become small and weak while the first anterior ray has become long and stiff and has developed on its tip an enlarged bit of flesh covered by a modified integument. This tip organ is usually called the lure or bait and is colored yellow or whitish, and has in some cases developed glands which secrete mucus or even have the power of luminosity in some of those members of the order that have adapted themselves to a deep-sea life. In one group, the bat fishes, this first dorsal fin ray is re-

duced to a short knob that may be retracted into a cavity. This first ray in all the forms has a jointed base and strong muscles to move it backward or forward, and it is commonly supposed that the fish uses it as a "fishing rod" to lure small animals near to or into its mouth where they may be caught and swallowed.

As for general features, we find those which tend to unite the group and others which have caused it to be divided into five main subdivisions. The members of the family are nearly all predatory, capturing other animals, principally fishes, and swallowing them whole, while some of the bat-fishes grub in the mud for food. As a rule the head is usually large and, together with what may be called the shoulders, forms the greater part of the body. Further, these fishes have a large mouth armed with long, sharp teeth and a wide throat. The stomach is so distensible that the fish can swallow other fishes nearly as large as itself.

In motion they are all very slow and usually move about but little. When moving they swim but languidly, and those kinds that live in contact with the bottom or on seaweed use the armlike pectoral fins almost like hands, as in a crawling animal. Consequently the body is soft, the muscle masses not large, and the general form does not have to be of the stream-line shape with large, hard muscles, so well shown in swift swimmers like the mackerel, swordfish, and striped bass.

This order has been divided into five families, but it is the writer's intention to confine this article to the first and best known of these, the *Lophidæ*, and especially to the angler *Lophius piscatorius*.

GENERAL CHARACTERS AND HABITS

The Lophidæ are the least specialized of the families and seem to represent most closely the stock from which they and the other families were derived. They form a homogeneous group which has been subdivided into only a few genera, and comparatively few species are known. These are widely distributed, being found in most north temperate and some tropical seas, and are alike in being fish of fair size, living in water of usually moderate depth although sometimes found in depths that almost entitle them to the term "deep-sea fish." The prominent member of this group is the large fish known as "angler" (Fig. 1) in England and found on both shores of the Atlantic, ranging north from Cape Hatteras on the American side and from the Mediterranean on the European coast. Its northern limits probably extend to the northerly parts of Scandinavia, and to Newfoundland and the Grand Banks. To the south, on the American coast it extends, in the deeper waters only (down to 350 fathoms), at least as far south as the West Indies.

The angler is a classic fish as can be understood when one sees it. So grotesque, so monstrous and so sinister in appearance is it, that it attracts the attention at once and is not easily forgotten. It is recorded in the literature of all ages, having been first observed and described by Aristotle under a Greek name which means a froglike fish. He observed the enlarged and specialized front ray of the dorsal fin and its filament (lure) and supposed that this was used for attracting its prey.

Wherever seen, its ungainly and grotesque form or peculiar habits have earned for it a new or a repeated old name until its synonymy has included such names as "angler." "fishing frog," "wide gape" (England); "monkfish (Maine); "goosefish"

(Massachusetts); "bellowfish" (Rhode Island); "molligut" (Connecticut); "allmouth" (Carolina); and from fifty to seventy-five other names in English and foreign languages. It is quite probable that the western Atlantic or American fish is a well defined

Fig. 2.—*Lophius americanus.* Photograph of the front of head, showing fishing rod erect (toward right of figure) with lure depending. The mouth is half open, showing teeth with membranous covers. Photographed at Salisbury Cove, Maine, by Dr. D. S. Johnson

variety of or even a different species from the European *Lophius piscatorius* and it has been named *L. americanus* by several authors. In this article, however, we will speak of both of them indiscriminately as *Lophius* or the "angler" unless otherwise stated.

When one sees the fish (Figs. 1 and 2), the first impression perhaps is that of its enormous head and wide mouth and the comparatively small tail and caudal fin. One next notes the flattened form of the body, adapted to lying on the bottom, and then its mottled brownish color with numerous rough projections and filaments of skin that wave about in the water and give it the appearance of a flat, dirty stone or bowlder on which much short seaweed is growing. This impression is so well expressed by the Duke of Argyle that a part of his account of the fish will be quoted here, although it contains some features that have not yet been scientifically proven. He writes:

> It is adapted for concealment at the bottom of the sea—for lying perfectly flat on the sand or among the weeds—with its cavernous mouth ready for a snap. For more perfect concealment, every bit of the creature is imitative both in form and in coloring. The whole upper surface is mottled and tinted in such close resemblance to stones and gravel and sea-weeds that it becomes quite undistinguishable among them. In order to complete the method of concealment, the whole margins of the fish, and the very edge of the lips and jaws, have loose tags and fringes which wave and sway about amid the currents of water, so as to look exactly like the smaller algæ which move around them

and along with them. Even the very ventral fins of this devouring deception, which are thick, strong, and fleshy, almost like hands, and which evidently help in a sudden leap, are made like two great clam-shells, while the iris of the eyes is so colored in lines radiating from the pupil as to look precisely like some species of *Patella* or limpet. But this is not all; not only is concealment made perfect to enable the *Lophius* to catch the unwary, but there is a bait provided to attract the hungry and the inexperienced. From the top of the head proceeds a pair, or two pair, of slender elastic rods, like the slender tips of fishing-rods, ending in a little membrane or web which glistens in the water and is attractive to other fish. When they come to bite, or even to look, they are suddenly engulfed, for the portals open with a rush and close again—portals over which the inscription may be written: *Lasciate ogni speranza voi che' entrate!*

The fish so vividly described above, and shown in lateral, dorsal, and ventral views in Fig. 1, is about three feet long and weighs in the neighborhood of thirty-five or forty pounds. Its flesh is very soft and flaccid and its outer surface exceedingly slimy. Few other fishes can give off the enormous quantities of tough, tenacious mucous secretion that this fish can. When undisturbed, the slime is not so apparent, but when hauled out on the deck of a boat and handled, and especially when killed and dissected, it leaves layers of mucus that are sometimes a quarter of an inch or more in thickness and very tough and hard. If plenty of water is supplied, this slime, which is at first opaque mucigen, absorbs the water and becomes the completed mucus, more voluminous and transparent and of course softer.

The creature's swimming powers and motions are slow but powerful. It swims by a curving stroke of its tail and caudal fin and if caught on a hook or tied by a rope can exert a considerable pull. The tail strokes are about one a second in each direction but can be increased four or fivefold when the animal is seized. It swims thus, off but near the bottom in its migrations which are done in easy stages, and it moves about in short trips from place to place quite often, as is evidenced by its getting into the fish traps frequently. When in such traps it is worried, and swims slowly about nosing the twine in an effort to find its way out, which it effects in a greater number of cases than the swifter-swimming mackerel and herring that pass these avenues of possible escape in their hurry and fright. Most of the angler's time however, is spent on the bottom, where it selects a rocky or gravelly bed on what is known as good fishing ground. Here it sometimes moves about, using both tail and a nudging movement of its armlike pectoral fins. Then it settles in some spot and waits for its prey, inert but watchful, over long periods of time.

FOOD AND FEEDING HABITS

We have but few reports based on actual observations of the way in which the angler secures its food. Most of our knowledge of its feeding habits comes from examining the contents of the stomach of the freshly caught fish. We thus learn that it feeds on a large number of animal forms, mainly however on other fishes as haddock, herring, dogfish, flounders, sculpins, etc., some of very considerable size but many surprisingly small compared with their captor. Furthermore, it often captures and swallows invertebrates of various kinds, especially such as move about on or near the bottom—squid, lobsters and crabs, and large swimming worms. Less often, but not infrequently, we find that the angler has caught and swal-

lowed sea fowl of several kinds. Seven wild ducks have been taken from the stomach of one individual, a wild goose has been found engulfed, and one fisherman has seen the struggle on the surface between a loon and the angler that had seized him by the head and neck and was engaged in pulling him under to drown and swallow him. Gulls are more often found in the stomach, and on several occasions *Lophius* has been known to show an entire lack of discriminating taste by swallowing the wooden buoys of lobster pots, thus annoying the fishermen.

Thus we see plainly that *Lophius* does not always wait on the bottom for his prey to come to him but is capable of slowly swimming and sneaking up beneath even large surface birds and seizing them by feet or head and swallowing them. It is also probable that, when but few fish are coming to his waiting jaws on the bottom, he will attack by stealth any slow-moving fish or other animal that may come within sight. No one has actually seen one of them thus engulf a fish nor has one been seen to eat when confined in an aquarium. He makes a poor aquarium subject since he refuses all food in captivity, and hence does not live long.

Since the fish seldom comes into water shallow enough for observation, but is usually caught at a depth of thirty or more feet, we are debarred from direct studies of its feeding habits. It has always been inferred, probably with some accuracy, that the fishing rod and lure were used to entice other fish to approach near enough to be caught. Aristotle stated this and countless observers since his time have had the same idea—the matter seems so obvious. Probably it is true and we have one observation that seems to confirm it. One observer who had a fish in captivity touched the lure with a broom handle. The lure was moving back and forth and whenever the broom handle came in contact with the lure the fish gave a gulping snap with its huge mouth and accurately seized the stick at the region where it had been in contact with the lure. This would indicate a very active and delicate reflex. Dr. Homer Smith has thus experimented on a *Lophius* but it was in poor condition and no accurate results were obtained.

The lure is attractive to small fish and the writer has used it as bait to prove that it will be attacked by them, numbers having been caught in this way. It is of a light yellow color, very different from the general color tone of all the rest of the body and would thus attract the eye. The "rod" or anterior dorsal fin ray on which the lure is placed is thin and stiff and at its base is provided with a series of muscles that move it back and forth from a posterior position in which it lies flat against the body, to one that is erect but leaning forward so that the lure hangs over the mouth (see Fig. 2). This would be its natural position in "fishing."

The mouth is of extraordinary size with the gape almost as wide as the head, and both upper and lower jaws are armed with a multiple row of very strong, sharp teeth of various sizes that curve slightly backward and appear to be capable of holding anything on which they may be set (Fig. 2). The jaws are so arranged that this mouth is capable of quick and accurate "gulping" like a dog.

Lophius does not disdain dead objects. It is caught constantly on small baits of chopped herring and shelled clams and is an occasional captive on the trawler's hooks. Hand-liners fishing with hook and sinker frequently

capture it. The writer caught three in this way off South Harpswell, Maine, in a single fishing trip, in about thirty-five feet of water. These fish were almost fully grown, about thirty pounds in weight, and although the hooks (baited with clams for small cod) were small and the lines thin, the fish were pulled up slowly, making a continuous heavy resistance, but were easily secured with the gaff. The comparatively tiny hooks, the clam bait, and the thin lines looked ridiculously small to catch these large fishes, and one could but wonder at their having noticed so insignificant bits of bait. Nothing large or small seems to escape their attention, however.

Fig. 3.—*Lophius americanus*. A small living adult (24 inches) in a tub of water. The fish had been tethered at the dock over night. The regions denuded of skin by starfish and sea-urchins show plainly as white areas on the right side of the head and the body. Photographed at Salisbury Cove by Dr. D. S. Johnson

Strange to say, the digestion of this fish seems to be unusually slow. We would expect to find a quick, strong, acid, pepsin digestion in such a voracious carnivorous animal. And this may be true in nature The fact remains that several persons have reported finding fresh fish that hardly seemed to have been touched by the digestive juices in its stomach hours after the fish had been brought to market.

In most carnivorous fish digestion goes on rapidly for a considerable time after the capture and even after the death of the animal, but we have many reliable reports of fish taken from the stomach of *Lophius* that were so fresh that they were sold in the market. Thus a man once sold a half bushel of herring so obtained. Dr. E. K. Marshall, at the Mount Desert Island Biological Laboratory, lately found a haddock twenty-two inches long in the stomach of a *Lophius* twenty-nine inches long. This was in apparently perfectly fresh condition, and there were no marks of teeth or of distortion or digestion although the *Lophius* had been caught at sea early in the morning, transported sixteen miles over land in a tub of salt water, and had had the haddock in his stomach for at least two days while he was tethered at the laboratory dock, alive.

PARASITES AND ENEMIES

Owing to its sedentary habits and its animal food, we might expect *Lophius* to harbor many parasites. This is found to be true, but strange to say, where we might expect to find many ectoparasites and commensals on his soft outside skin with its many crannies and appendages, we find but few. Occasional trematodes and leeches are found, but never the large copepods, and seldom the flat "fish-lice" and smaller copepods so common on the body and in the gills of fish that live a still life. This is probably due to the large secretion of mucus by the skin, which acts as an automatic mechanical cleaner, a fact that is more or less true of all bony fishes. It may be that the skin also secretes some extra poisonous or offensive substance that discourages such visitors.

As to internal parasites, we find large numbers of tapeworms, trematodes,

and above all, nematode worms, which enter by way of the mouth in the bodies of its prey, and may be found in the walls of the digestive tract, in the tissues of the internal organs, especially the liver, and in the connective tissues lining the body cavity.

A very interesting fact in connection with attacks on the fish's exterior has been observed by the writer both in free and in captive anglers. A number of these fish were brought in alive to the Mount Desert Island Laboratory for physiological experimentation. Each one was confined in the sea by tying a rope around one pectoral fin (or "arm") and tethering it to a stake or post on the floating dock in front of the laboratory. The water here was from ten to twenty-two feet deep and the fish had plenty of rope so that they could move around for a distance of 20 feet in any direction. The fish actively swam about or lay quietly on the sandy or muddy bottom for longer or shorter periods. This bottom was inhabited by some starfish (*Asterias forbesi* and *vulgaris*), and sea-urchins (*Strongylocentrotus drobachensis*), which were rather widely distributed and ordinarily not much in evidence. After a *Lophius* was thus tethered for twenty-four hours, large numbers of the starfish and some sea-urchins were found to have crawled on to his back. Here they clung fast and soon ate the outer layers of his skin, the starfish applying their stomachs and digesting the skin while the sea-urchins gnawed it off in smaller patches (see Fig. 3). When once attached by their ambulacral feet, the starfish and urchins are not easily pulled off, and it does not seem possible that *Lophius* can shake or rub them off unaided.

A *Lophius* would be able to live under these circumstances for only a few days and two questions at once arise; why was he unable to defend himself against these attacks when he could swim with almost normal freedom, and second, what does *Lophius* do in his natural habitat to protect himself against these enemies? He is supposed to remain lying on the bottom for long periods, waiting for his prey, and such a habitat abounds in starfish and sea-urchins. It is notable, however, that when tied to the dock he was farther inshore and in quieter waters than he is ever found in when free, and it is possible that when free he carefully avoids the vicinity of the starfish and sea-urchins.

In this connection the writer has observed, and many intelligent fishermen have told him, that in October and November considerable numbers of large adult *Lophius* come into shallow water and appear in the bays and coves, swimming very feebly and nosing into the beach where they are left to die stranded by the retreat of the tide. The popular opinion is that these are fish that have been enfeebled by old age, and that they come ashore to die. They often show the same ragged patches of denuded skin seen in those that have been attacked by the starfish. So many die in this way each fall that their bones, particularly the characteristic mandibles with their long sharp teeth, are one of the commonest objects seen on our beaches, lying above the high-water mark, dry and bleached, where they have been thrown by the winter storms. The writer advances the theory that, when *Lophius* comes into the shallower coastal waters in response to the seasonal changes and in pursuit of food, he is here often attacked by the littoral starfish and urchins and so weakened that he dies. Specimens captured on

the outer fishing grounds never show traces of this condition.

BREEDING HABITS—THE EGG RAFT

Most specimens of *Lophius* taken in our Atlantic waters from Nova Scotia to Virginia are of large size, three feet or more usually, but occasionally one will appear that is not much over a foot long. However, one is much puzzled to conjecture where their young may be. The young of many other fish may be seen swimming along shore when mere "pin heads," or coming up into the shallow water in late summer, especially toward night, sometimes in countless thousands. An evening's seining on a sandy beach at Nantucket, Massachusetts, furnished young mackerel, kingfish, gurnards, flounders of several species, young bluefish, scup, herring, and many other young fishes, but never a young angler!

Even the professional fisherman can give no information on this subject. And the average professional naturalist can say with the observing fisherman that he has seen only two stages in the fish's life history, the grown adult and the eggs, the latter noticeable because they form a huge "purple veil" or ribbon or raft of jelly that is about 30 feet long, 2 or 3 feet wide, and only 3 millimeters in thickness. This is occasionally seen floating about in the open sea or caught on some fisherman's net or line.

The mystery of the breeding habits of *Lophius* has been largely solved, however, partly by casual observations, but mainly by the hard work of such scientists as Agassiz, Whitman, McIntosh, Prince, Bowman, Lebour, Schmidt, Stiasny, Tåning, and many others. In brief it may be summed up as follows:

The fish does not breed in shallow or in brackish water, but goes off shore to deeper haunts and lays its eggs on the bottom of the open sea. The two ovaries of the female are peculiarly constructed for this purpose. They form two wide, long, and thin-walled tubes,

Fig. 4.—*Lophius piscatorius.* A small bit of "veil" with numerous eggs—much magnified. The completed veil will have from one to two million eggs. Original

Fig. 5.—*Lophius americanus.* Newly hatched larvæ still in the jelly of the "veil." They have broken out of the egg capsules but will stay for a day or more in the jelly of the veil. One egg membrane is not yet ruptured. Original

much folded up in the body cavity and the two opening to the outside by a single orifice separate from and behind the opening of the intestine. Each tube on one side of its length is given over to the production of numerous eggs that mature in thousands of small papillæ. On the other side we find a surface that is studded with mucous glands so that the egg-producing papil-

læ are always pressing against the mucous secreting surface. When the ripe eggs, which are usually situated in or near the tips of the papillæ, rupture the egg-sacs, they are naturally unavoidably pressed into the layer of mucus that is secreted at this time by the other side of the ovarian tube.

When the eggs have become embedded in the mucous veil, this ribbon-like structure becomes detached from both sides of the flattened, tubelike ovary, and passes down the tube and out into the sea (Fig. 4). This process would be interesting to watch could we observe it, and some research worker may some day catch a *Lophius* out on its spawning grounds just before the eggs are laid and thus be able to watch the process. Another fish, *Pterophryne histrio*, a cousin of *Lophius*, has the same breeding methods but is much smaller and easier to study. The laying of these two ribbons of eggs probably takes some time on account of their length and the smallness of the passage.

The egg raft probably swells to its final length, width, and thickness only after coming out into the water. At this time it has a faint yellowish-white color with a purple fluorescence in certain angles of the light. It is possible that the slight yellowish opacity is due to the mucous material. Unfortunately no analysis or chemical study of the "veil" has ever been made.

As has been said, all the ripe eggs in the ovaries are discharged at this one time in the two ribbons. Some eggs, however, fail to become seated in the ribbon and others become detached shortly after laying. Such free eggs float to the surface and there develop. Each egg is not strictly round but slightly elongate. Its longer diameter is about 1.75 mm. and the other a little less. There are several fairly large oil droplets in it such as many pelagic fish eggs possess. A short time after development begins the larger of these several oil droplets coalesce forming one large drop with some very small ones next to it.

The number of eggs in a raft of course varies but has been rather carefully estimated at about an average of 1,000,000 in the veils from the usual sized fish. Fulton calculated the numbers in two veils as 1,345,848 and 1,312,587 respectively.

On the whole this veil has a tendency to float. The eggs, separated from the jelly, readily rise to the surface. The jelly material of the structure is slightly heavier than water and, alone, it will sink. The two together are *almost* balanced. The extent and thinness of the veil make it entirely subject to any current, however slight. As most bottoms of the sea are subject to some currents, the veils must be borne about by these, and as the fish is known to prefer a rather rough bottom, it seems probable that the veils must catch on various marine growths and projections and be more or less anchored most of the the time. Thus they would be held near the bottom until the young fish are freed. On the other hand, very slow currents will often carry the veils upward until they impinge on some bank or rock where the soft jelly is easily torn.

There are comparatively few records of the finding of these veils. On the Maine coast, however, the writer has found several and every fisherman and lobsterman has seen them Usually these rafts are not perfect, and often one finds only a part containing a few thousand eggs with the embryos nearly always in an advanced state of development (Fig. 5). Owing to this develop-

ment the color has become darker and the purple sheen stronger. It seems probable also that all these veils that float inshore do not liberate healthy and normal young fish and that these young fish do not live beyond a rather early larval life. Only those eggs that remain on the pelagic breeding bottom, floating around in suspension or caught lightly against some rough projecting object, have the best chance for maturing. There are some writers who believe that most veils normally float in suspension near the surface, but here again we must collect more well established facts than we already have in order to learn the truth.

One thing seems certain, a rather large proportion of mature eggs (let us assume 5 per cent) fail to become firmly embedded in the jelly layer but are nevertheless extruded. These eggs by virtue of their higher specific gravity must quickly come to the surface. Their occurrence would thus mark out the breeding areas of the adult fish more accurately than would the occurrence of the veils, provided only the very earliest stages were used, for at the surface the veils would be more widely scattered because of the stronger surface currents.

The method of fertilization of the eggs by the male is entirely unknown and can only be guessed at. As he has no intromittent organ as have the sharks and rays and bony fishes of several groups, we must assume that one or more males are present when the egg ribbon is laid, and that they eject a sufficient quantity of milt near enough to the ribbon to insure the fertilization of practically all the eggs, as is proved by their development. This method is much like that of our frogs and toads where the spermatozoa have to penetrate the jelly that surrounds the eggs.

LARVAL AND POST-LARVAL DEVELOPMENT

The exact time of development of the larva up to the hatching period has not been accurately determined and is not at present of major importance since we know the latter part of this period and can come rather close to an accurate estimate of it from comparison with the larval histories of other teleostean fishes. The end of the larval period proper comes when the young fish ruptures the egg membrane, but still it does not emerge from the jelly for a variable time after that. Also, according to the temperature of the water, the embryos will develop slower (in colder) or faster (in warmer water).

We can put this larval period proper at about 3–4 weeks (Fulton) without too great a probability of error, and the period during which the young fish remains in the jelly raft at 1–3 days (Fig. 5). It then comes out free in the water and swims about (Fig. 6) a post-larva. This post-larval period may be divided into two parts, during which the fish's growth and structure seem aimed at two entirely different and distinct purposes. The first is to fit it for an efficient and active pelagic life; the second is a series of gradual changes that result in fitting it for the lazy bottom life above described. The fishlet passes a considerable period in the first stage, longer than most fishes.

Without going into too much detail, we may say that the little fish's adaptation for the post-larval pelagic existence consists in three factors. His body, especially the head, grows narrower rather than flat, thus taking the form of a fish that is to move rapidly through the water. The second adaptive feature consists in the development of his fins into comparatively enormous surfaces that are to prevent him from

sinking when at rest or moving slowly, a "plane" form which is adopted by many young (and some adult) pelagic organisms (fishes, crabs, and worms) found near the surface of the sea.

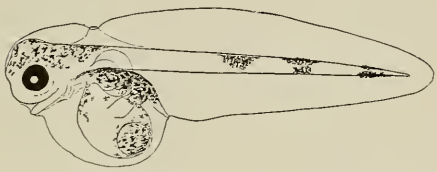


Fig. 6.—*Lophius piscatorius.* Newly hatched larva of 4.5 mm. After Å. V. Tåning

The third feature is a combination of reflexes and habits,—his swimming, which has been described by Stiasny as mostly performed by a fluttering motion of the great fins, and his erratic course in search of particles of food. He has no fishing rod or lure at this time, but actively darts about picking up first small organisms such as diatoms and later young and then adult copepods. His ventral fins move with a lively up and down motion while the large pectorals also vibrate strongly. A wide dorsal fin arises from his back and gives him stability in the water, and when he ceases all fin motion he appears to lie suspended although in reality he is sinking very slowly, since his specific gravity like that of most fishes is slightly greater than that of the water.

The distribution of the young post-larval stages is from the seaward shores out to and just over the edge of the continental slope. They are not found in the smaller bodies of water, hardly entering into the North Sea in Europe, and those that do probably not developing to maturity. On the American coast the post-larval stages are also found distinctly off-shore, to the extent of being most frequent near the edge of the continental shelf, although our prevailing southwest winds often bring them in nearer the coast.

Thus it is fairly easy to get the developmental stages of the fish during its life in the egg and also easy, with some care, to hatch these eggs out in the laboratory and keep the young fish for a few days. At first they get their nourishment from the yolk-sac which persists after hatching, but even at this time they begin to eat minute diatoms and other organic particles. Soon, however, the fish thus hatched in captivity cease to grow and die shortly after the yolk-sac has been absorbed.

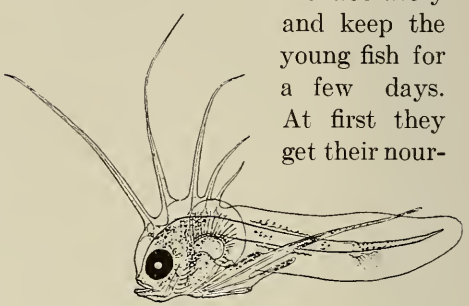


Fig. 7.—*Lophius piscatorius.* Post-larva of 11.5 mm. The first dorsal and the ventral fin rays are beginning to elongate. After Å. V. Tåning

This very clearly indicates that our only hope of tracing the history of this fish, from shortly after hatching to the time when he has become a settled "ground fish," will be in following up his post-larval life at sea and piecing together the various facts that we are able to secure by using the tow-net. This has been done in part by the workers already mentioned, especially Tåning, who has had access to some of the best material secured by the Danish oceanographic expeditions.

An important contribution to the solution of this problem has been to record the capture of the smallest adult specimens that have been taken. These specimens, although rare, are not so scarce as the post-larval stages. At a point off Lybster in British waters no less than thirty-six young anglers, ranging from five to eight inches in

length were taken in one haul of a dredge. These fishes, although settled bottom forms, give us no very exact limit to the end of the post-larval existence. Fulton gives a list of the smallest bottom captures and in this we find that the lower limit of bottom size appears to be about 50–60 millimeters. The transition from post-larval existence to bottom life is evidently gradual,

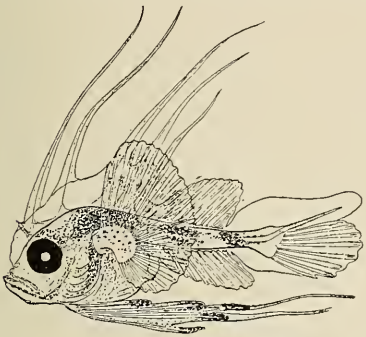


Fig. 8.—*Lophius piscatorius.* Post-larva of 16.5 mm. The caudal fin has appeared and the elongation of fin rays has continued. After Å. V. Tåning

more so than in a fish like *Astroscopus.* It may even vary greatly in different individuals and especially under different conditions of temperature and season, character of bottom, availability of food, etc.

Omitting, for the present, features due to varietal or specific differences, let us try to extract from the excellent works of Stiasny, Fulton, Lebour, Tåning, and others a general conception of this post-larval history.

The newly hatched larva (Fig. 6) is able to swim and has several days in which to learn to eat living organisms for food, being nourished meanwhile by the absorption of its yolk-sac. This yolk-sac, the large oil globule helping, tends to carry the baby fish up, and these stages are thus found in the u per strata of water, but not usually at the surface. Tåning speaks of them best found at 15-75 fathoms down. It appears that the youngest forms live higher up in the water, probably buoyed up by the yolk-sac. After this is partly or wholly absorbed, the young post-larva tends to live in deeper strata of water

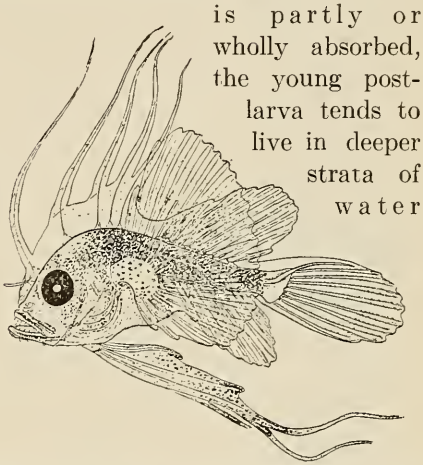


Fig. 9.—*Lophius piscatorius.* Post-larva of 26 mm. The enlarged surface of all fins is now apparent. The "fishing rod," which is first seen in preceding figure, now projects from the head. After Å. V. Tåning

but its level must have varying factors to determine it as it is not confined to well established limits.

It is at this time that the structures favorable to its free swimming open sea life begin to appear. An embryo of 11.5 millimeters in length shows this well (Fig 7). The dorsal fin rays, five in number, have grown up through the fin fold to great lengths, the ventral fin rays have elongated so that one of them reaches almost to the caudal extremity, while the pectoral fin has enlarged in lesser measure and the caudal fin has not yet appeared.

At 16.5 millimeters (Fig. 8) the anterior dorsal rays have continued to enlarge but not so greatly. The ventral fin has reached the caudal extremity and developed a web of some extent for support in the water. The second dorsal and anal fins have appeared, giving the body large vertical surfaces, and the caudal fin has appeared on the ventral side of the spine axis in eight rays and a complete web. The pectoral

has enlarged to a great plane that can be used in the vertical or the horizontal position or at any intermediate angle and it is plainly the principal propulsive organ at this stage.

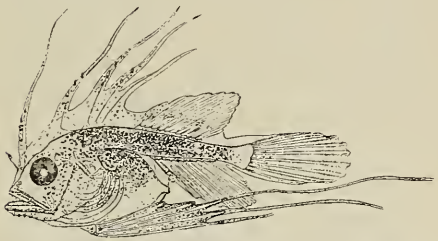


Fig. 10.—*Lophius piscatorius.* Post-larva of 32 mm. The pectoral fin has been removed in this specimen in order to show more clearly the other structures. This stage, in which the lure has begun to develop on the "fishing rod," is close to the maximum development for pelagic life. After Å. V. Tåning

At 26 millimeters the anterior dorsal rays have not gained in comparative length (Fig. 9), but the first dorsal ray, which was but a rudiment in the 16.5 millimeter stage, has pushed through and is beginning to elongate slightly. This ray is destined to become the "fishing rod" with its "lure" on the tip, but it now will remain backward in development during the whole post-larval stage and until after the fish has settled on the bottom at a much later period.

A considerably older stage is shown in Fig. 10 of an embryo of 32 millimeters. In this stage the maximum length of the ventral rays has been attained and is probably past. The first dorsal rays are stationary in length and are beginning to thicken. The pectoral, although it has been removed to show other fins, is still very large and may be said to have reached its maximum in extent of surface. In fact, we may say that at this age the fish has attained the height of his adaptation for the free pelagic life. Only the mere rudiments of any adaptation to his future bottom life have appeared in the presence of the beginning of his fishing rod and an indication of the lure, in a slight thickening of the dorsal rays with the appearance of dermal appendages, also in a slight comparative shortening and thickening of the body together with a greater development of the head in proportion to the trunk.

TRANSITION FROM POST-LARVAL TO ADULT FORM

In the next stage figured by Tåning (my No. 11), from a 46 millimeter specimen, we see marked features in regression from the post-larval characters and in development of the adult features. The first dorsal rays have shortened and thickened. The lure has

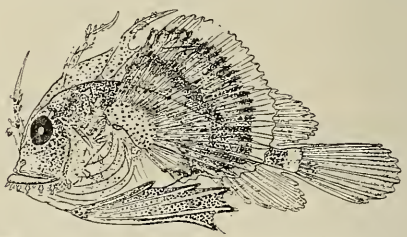


Fig. 11.—*Lophius piscatorius.* Post-larva of 46 mm. A pelagic stage in which the permanent features of the adult ground stage have begun to develop. The "fishing rod" or first dorsal ray has acquired its lure. After Å. V. Tåning

developed in form but remains small while the fishing rod remains short. The pectoral is still the large propulsive organ but the second dorsal, caudal, and anal fins, and the ventrals have comparatively decreased. It is evident that the fish has to work harder to keep itself up in the water and that the proportional weight of the body has increased considerably, especially in the head region.

Fig. 12, which was photographed from Tåning's largest post-larval specimen, evidently represents a stage in which the post-larva has acquired a form so much like the adult that it is ready to assume the bottom life. How gradual or how sudden this change of

habitat may be we have no means of telling. Probably it extends over several weeks or even months, the two-inch fish at first resting temporarily on the bottom and making shorter and shorter excursions into the waters above it. Probably the three-inch fish

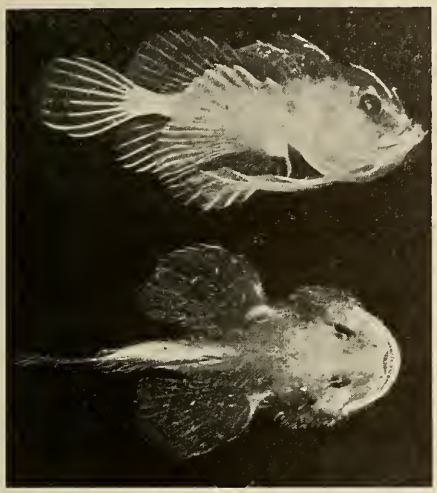


Fig. 12.—*Lophius piscatorius*. Photograph of top and side of a 60 mm. postlarva, the largest ever taken. This stage represents a fish in the process of changing from the pelagic to the ground life, as is shown by the widening and enlargement of the head and by the large size of the pectoral fins. After Å. V. Tåning

is pretty well established on the bottom. Many post-larval fish like this must be lost by drifting too far from their future habitat to be able to live. Most of them settle in deeper areas and only come inshore when well grown.

SOME INVERTEBRATE ENEMIES OF THE YOUNG *LOPHIUS*

Elsewhere we have considered some enemies of the adult *Lophius*, but the larval and post-larval young also have many enemies to escape if they are to grow up. Miss Lebour working at the Plymouth (England) laboratory has discovered and figured certain small invertebrates which preyed on the baby Lophii in her hatching jars, and which presumably feed on the fishlets in the open seas. The four figures now to be given are copied from her report.

In one of these jars containing little anglers, there were young forms of a ctenophore jelly fish with a blunt-lobed body. These were feeding on the abundant copepods and it was thought that they would not bother the little anglers. However, the young Bolinas (ctenophores) readily caught the little fishes as is shown in Fig. 13 The *Bolina* would encircle the actively moving *Lophius* with its blunt tentacles (a) and the struggling fish would be

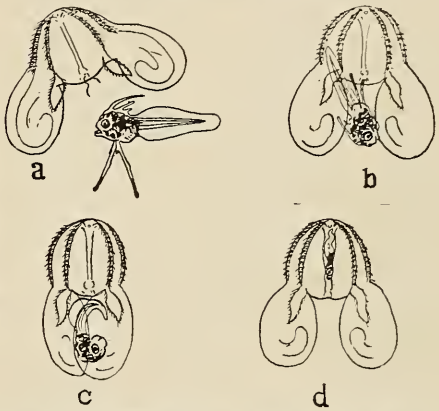


Fig. 13.—Four stages in the catching and eating of a *Lophius piscatorius* larva by a ctenophore in an aquarium at Plymouth, England. After Dr. Marie LeBour

completely enclosed by the tentacles and brought to the mouth (b and c). Thence it would be carried to the stomach and digested (d). Thus Bolinas from 4–30 mm. long would catch and devour anglers from 1–10 days old, the smaller ones taking in one fish, the larger ones sometimes two.

If the young angler escaped the tentacles of the ctenophore, it was likely to fall into the clutches of the *Phyllosoma* larval stage of the rock lobster (*Palinurus*), or as it is called in our southern waters the "salt-water crayfish." Figure 14 shows a *Phyllosoma* that has seized and is devouring a baby angler. These larvæ abound in the water of the open sea at Plymouth,

and must account for a great many little anglers. However, this is not the only crustacean enemy of the baby anglers. An active copepod called

Fig. 14—Showing the manner in which a Phyllosoma larva seizes a larva of *Lophius piscatorius* to eat it. After Dr. Marie LeBour

Anomalocera was also found to seize and devour fishlets of about its own size in the hatching jar. These little anglers were still undergoing larval development, weak and encumbered with a yolk-sac (Fig. 15) poor swimmers and easily overtaken.

There was still another enemy which fed on the little fishes when they descended to the bottom of the jars, and which acted more as a scavenger than a real enemy. This was a small hydroid, *Clytia* by name, which was forming colonies on the floor of the jar. These small "beasties" (only about 3 mm. long "over all") stood with tentacles outspread and whenever a fishlet touched one this would activate others as is shown in Miss Lebour's spirited sketch (Fig. 16 herein), until as many as three hydroids were found fast to and devouring one baby fish.

In view of the facts set forth in the preceding paragraphs well may Miss Lebour speak of ". . . the vicissitudes to which the little fishes are subjected."

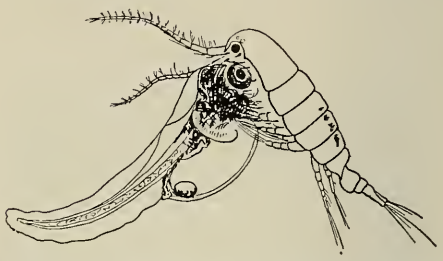


Fig. 15.—A *Lophius piscatorius* larva that has been caught and is being eaten by a copepod, *Anomalocera*. After Dr. Marie LeBour

And if they meet with these in the comparatively safe shelter of a hatching jar, what must they suffer in the open sea from other fishes, young and

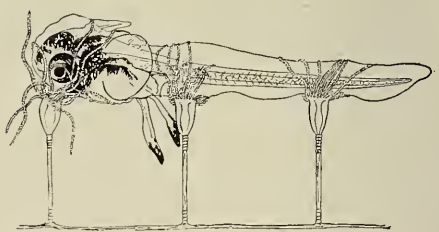


Fig. 16.—A larva of *Lophius piscatorius* that has been caught and is being eaten by three Campanularian hydroids. After Dr. Marie LeBour

old, from squids, crustacea of a hundred kinds, from worms—in a word from the millions of hungry carnivores which crowd the waters, all seeking what they may devour.

THE LOUSE-FISH (*PHTHEIRICHTHYS LINEATUS*) IN NATURAL COLOR (GREEN PHASE)

Reproduced by courtesy of Mr. W. K. Vanderbilt

Painted by William E. Belanske while on the "Ara" expedition of 1926 to the Bahamas and Galápagos Islands

The Louse-fish (*Phtheirichthys lineatus*)

WITH AN ILLUSTRATION IN COLOR

By E. W. GUDGER
Biographer and Associate in Ichthyology, American Museum

EARLY in 1926 (January 20–April 9), Commodore W. K. Vanderbilt led an expedition to the Galápagos Islands by way of the Bahamas and the Panama Canal. This was intended not merely as a pleasure cruise, but had the more serious purpose of collecting natural history specimens—particularly fishes—for his private museum at Northport, Long Island. In order that accurate color sketches from life might be made of the fishes, there went as a member of the "Ara" expedition, Mr. Wm. E. Belanske, a skilled artist, who has had much experience in making color drawings of marine animals for and under the critical direction of various members of the scientific staff of the American Museum.

Mr. Vanderbilt, who is a trustee of the American Museum, has published privately an interesting account of his expedition and in this has reproduced in a style worthy of their excellence Mr. Belanske's beautiful paintings of twenty-seven fishes. The originals of these figures have been presented to the department of ichthyology of the American Museum, and (properly mounted) are now on display in our new hall of fishes. Inspection of these will justify the statement that no more lifelike representations of fishes have ever been made. Ichthyologists owe Mr. Vanderbilt a debt of gratitude for these entirely adequate color figures of the rare fishes taken on this expedition, at least one of which is new to science.

Plate XXIV of the work referred to shows the rare and exceedingly interesting little sucker-fish known as *Phtheirichthys lineatus*.[1] This is the first and only known portrayal in life colors of this member of the Echeneididæ, and thanks to Mr. Vanderbilt's kind permission to use the plate, I am able to reproduce the figure in this article and make it available for ichthyologists. The fish itself had already been briefly described by me in a paper dealing with other small Echeneids of this and other genera.[2]

This rare specimen (which lies before me as I write) was taken from a barracuda caught with hook and line off Hogsty Island in the Bahamas on February 13, 1926. It was at once put alive and unhurt into an aquarium of fresh sea water, and then and there was made the painting of which the plate is an exact reproduction. Fish and figure are described on pages 145–146 of Mr. Vanderbilt's book. This fish was of a uniform green color, practically black-green on the head and pelvic fins, on the basal parts of the pectorals and of the dorsal and anal fins, and on the anterior half of the caudal fin and the whole of its median lappet. Along the mid-lateral region of the fish (over the lateral line) runs a light green stripe, above and below this are darker green bands and, finally, along the roots of the dorsal and anal fins are likewise light green lines. The pectorals, the high anterior parts of dorsal and anal fins, and the upper and lower lobes of

[1]Vanderbilt, W. K. *To Galápagos on the Ara* [New York, 1927, privately printed] pp. 14, 145–146, pl. xxiv.

[2]Gudger, E. W. "A Study of the Smallest Shark-suckers (Echeneididæ) on Record," etc. *American Museum Novitates*, 1926, No. 234, pp. 10–13; 23–24.

the caudal are in color a light green merging into white. Further consideration of the color of this particular fish will be taken up later in connection with that of other specimens of this species and of other members of the family.

This small sucker-fish is 64 mm. long "over all," 51 mm. in standard length, and has a caudal fin 13 mm. long to the end of the central lappet. With one

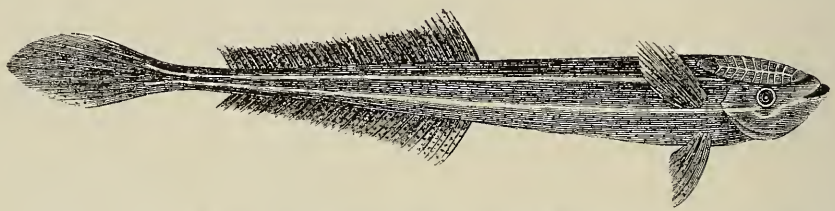


Fig. 1.—The earliest known specimen of the louse-fish—"about five inches long"—taken from a marine turtle in the tropical Pacific ocean. Note the spatulate or plumose tail, indicating that this fishlet is about half-grown. After Menzies, 1791

possible exception (to be referred to later) it is the smallest known specimen of the genus. The sucking disk has ten lamellæ only—the smallest number found in any living member of the family. There is, however, a fossil form (*Echeneis glaronensis*) from Switzerland with the anterior portion of the disk gone, which has 5 lamellæ remaining, and which (as I have elsewhere shown) could not have had more than 2 or 3 additional lamellæ—or from 7 to 8 in all.

The first known specimen of our little sucker-fish was about 5 inches long (125 mm.) and was taken from a turtle in the central tropical Pacific ocean. Archibald Menzies,[1] its describer, thinking it to be an ordinary striped echeneid, designated it as *Echeneis lineata* in 1791. For comparison's sake, his figure is reproduced herewith as No. 1. His specimen was presumably about one half to one third grown.

The present specimen was taken from a barracuda, and the only other recorded American specimens were also taken from barracudas. Thus Poey,[2] the Cuban ichthyologist, says of the sucker-fish which he calls *Echeneis sphyraenarum*, that "This little *Echeneis* has thus far been found only on the *Sphyraena picuda*. It hides itself between the gills and escapes thence when the large fish is taken." Hence Poey gives it the common name "*Pega de las Picudas*." His specimen, which had been much shrunken through long immersion in alcohol, was 75 mm. (about 3 in.) long, and had 10 lamellæ in its disk. The tail fin had a central lobe about one and one half times the length of the caudal proper. This lobe he found on all his specimens, and hence he thought it a distinctive character. The color of the specimen described was "a very dark blue verging on to black."

My personal knowledge of this species is confined to one possible specimen. This was taken from a barracuda caught by trolling at the Tortugas, Florida, late in the afternoon of July 4, 1914. It was put in an aquarium of running sea water and during the night escaped down the drain pipe or was carried away by a cat, hence it

[1]Menzies, Archibald, "Descriptions of Three New Animals Taken in the Pacific Ocean." *Transactions Linnæan Society London*, 1791, Vol. 1, p. 187; pl. xv, fig. 1.

[2]Poey, Felipe. *Memorias Sobre la Historia Natural de Cuba*. Habana, 1856, Vol. II, pp. 252–255.

was not positively identified. But, from its small size (about 4 in.), its plumose tail, and its capture on a barracuda, it is believed to have been *Phtheirichthys*.

That this Echeneid is found on the barracuda is undoubted, but Poey's contention that it is found only on this fish is not tenable, inasmuch as Menzies' specimen came from a turtle.

of the fin proper. This specimen, then, presuming that it was drawn *life size*, was 3 mm. shorter than Mr. Vanderbilt's. Günther's figure is here reproduced as No. 2.

It is noticeable that up to this point all the authorities quoted call our fish *Echeneis lineata*. Now Linnæus long ago applied the generic name *Echeneis* to sucking-fishes having 20–28 lamellæ

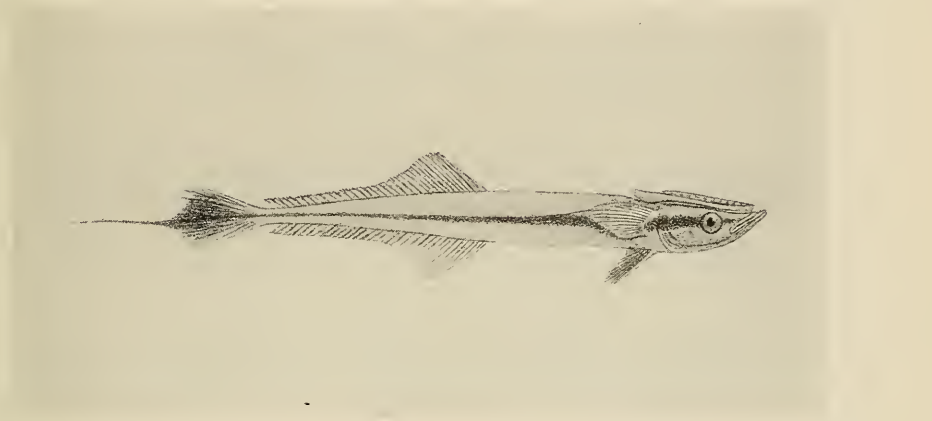


Fig. 2—A post-larval louse-fish showing the prolonged central lappet of the caudal fin. Presumably a life-size figure (85 mm. or 3.4 inches in total length) of a specimen in the British Museum. After Günther, 1876

The opinion is generally held that certain species of sucker-fishes are found only (or at any rate mainly) on certain host fishes. This has not been proved, but it is a matter of no small interest and worthy of considerable study.

Günther,[1] in working over the fishes collected in the South Seas by Andrew Garrett found a small *E. lineata*. This he figures, presumably in life size though he gives no scale. The fish as drawn is 61 mm. (2.5 in.) in standard length and 85 mm. (3.4 in.) over all. The caudal is 24 mm. in total length, of which the central lappet projects 13 mm. (0.5 in.) beyond the hinder edge

in the disk, so plainly our fish with 9–11 lamellæ cannot belong to this genus. As a matter of fact, that keenest of all American ichthyologists, Dr. Theodore Gill,[2] had in 1862 given it the name which it now bears—*Phtheirichthys lineatus*. This name became fixed in the literature by the publication in 1882 of Jordan & Gilbert's *Synopsis of the Fishes of North America*.

The name *Phtheirichthys lineatus* literally translated means the striped louse-fish. The question of stripes will be discussed later, but just here it may be well to call attention to a short article which I published in 1916,

[1]Günther, A. C. L. "Andrew Garrett's Fische der Südsee", Bd. II. *Journal Museum Godeffroy*, 1876, Bd. IV, pp. 156–157, pl. xcvii, fig. 1.

[2]Gill, Theodore N. "Remarks on the Relations of the Genera and other Groups of Cuban Fishes." *Proceedings Academy Natural Sciences Philadelphia*, 1862, Vol. 14, p. 235.

which has some bearing on the matter of the name louse-fish.[1] In this article, Aristotle is quoted concerning a sucking-fish that accompanied dolphins found in the waters between Cyrene and Egypt, and which was called the "dolphin's louse." Further, Hasselquist (1762) and later Forskål (1775) were quoted that in their time sucking-fishes found on sharks around Alexandria and at Djidda on the Red Sea were called respectively *Chamel el Ferrhun*, "the louse of the terrible one" (i. e. shark); and *Kamel el Kersh*, "the louse of the fish of prey" (a *Carcharias* shark according to Forskål). Here, then, we have the name louse-fish given to Echeneid fishes in classical antiquity and as recently as 150 years ago in near-eastern waters. Gill's giving the name *Phtheirichthys* (louse-fish) in 1862 to our small Echeneid has good warrant, then, in times as far back as Aristotle.

We now come to the matter of the color of this fish, and here, as in all cases of consideration of the color of tropical fishes, we are treading on uncertain ground. Many if not most tropical fishes have from 3 to 6 color phases, and when such a fish is caught one cannot describe it by its color unless one knows in what phase it is. To study these phases one must have had long experience and accurate observations of the wild fishes on the reefs or of tamer ones in the artificial conditions of captivity. Only a few months ago, at the New York Aquarium, I saw three specimens of the common shark-sucker, *Echeneis naucrates*, resting side by side on the bottom of a tank. One was light ash color without trace of stripes, one almost black with no stripes, and the third with the normal longitudinal stripes—a central black stripe from eye to caudal, above and below this white stripes with black regions above and below these.

Ichthyologists are exceedingly fortunate in having this color drawing of Mr. Vanderbilt's specimen of *Phtheirichthys*. That the fish was in the green color phase is beyond doubt—Mr. Belanske's painting must be taken at its face value. As to other specimens of this species, the facts are as follows. My living specimen of a presumed *Phtheirichthys* was black all over save for white on the head about the eyes and on the outer tips of the caudal fin. Poey (1856) described his specimen as "a very dark blue verging on to black."

That the common shark-sucker (*Echeneis naucrates*) has different color phases, I have noted above. That it may have other colors than those supposed to be normal will now be shown. First let Temminck and Schlegel be quoted that a specimen taken in the bay of Nagasaki, Japan, was grayish blue (lead color) with irregularly shaped and placed lighter blotches all over the body; the back (in front of the dorsal), the paired fins, the caudal, and the high front parts of dorsal and anal were a smoky black. Their colored figure shows the most unusual markings of any Echeneid known to me.

Furthermore, on July 8, 1914, I took from a nurse shark at Tortugas an *Echeneis naucrates* having much the coloration shown in the plate of *Phtheirichthys*. Looked at from above, the body was dark green, almost black, edged with a white line below on each side. Viewed from below, one found the same dark slate-green edged with white. Furthermore, Poey (1856) described a sucking-fish under the name *Echeneis metallica* (=*E. naucrates*). Of its coloration, he says that: "It is a dark green, gleaming or

[1]Gudger, E. W. "Aristotle's Echeneis not a Sucking-fish." *Science*, 1916, Vol. 44, pp. 316–318.

metallic; paler on the throat and under the head; having a band of darker green starting at the edge of the opercle, passing the eye and terminating at the maxillary. . . . This very rare fish was taken near the *Sagua la grande*, an old channel in Bahama." I have been unable to identify this region, but apparently it was in the Bahamas, whence our present-day specimen comes. It certainly is significant that it had much the same coloration as ours taken in this same general region seventy-five years later.

Here, then, we have, from two different specimens of another genus of sucker-fishes, confirmation of the accuracy of the coloration of the specimen shown in the plate. One of these specimens comes from the same general locality (Bahamas) and the other from the not distant Tortugas. When I studied and described my fish, I thought that I had chanced on an entirely new and unheard of color for an *Echeneis*.

All other specimens of *Phtheirichthys* studied have been preserved ones. Tanaka's (1913) Japanese specimen from Misaki, Sagami Bay, (212 mm. in total length) was dark brown in general color with two pale longitudinal lines separated by a brown band running along the lateral line as shown in his figure. Franz's (1910) specimen from the same locality after long immersion in preservative is described as having a practically identical coloring.

Günther's preserved specimen from the South Seas (1876) is described as having light areas above and below separated by a mid-lateral brown band, as shown in his plate (my Fig. 2). All of Lütken's specimens after long sojourn in alcohol had the dark laterally placed band separating lighter regions. Poey's (1856) preserved and much shrunken fish was "clear blue above, verging on to black," and earliest of all, Menzies' (1791) preserved fish (the type specimen) was brown all over save for two longitudinal white bands from eye to tail. (See my Fig. 1.) Furthermore, the brown areas were dotted all over with darker spots.

Mr. Vanderbilt's specimen, which has now been in preservative for fifteen months, today shows the following coloration—a narrow dark band from eye along lateral line to caudal fin, above and below this lighter (brown) areas dotted all over with minute darker spots. Thus the color of this fish after long action of the preserving fluids is practically that of all others which have had similar treatment.

As has been shown in my 1926 paper elsewhere referred to, the elongated central portion or lappet of the caudal fin in the Echeneis group of the sucker-fishes (*Echeneis* and *Phtheirichthys*) is a larval, or better, post-larval character. As figures of older specimens of the latter fish by Menzies, by Tanaka, and by Günther show, the caudal fin in specimens 125 mm. (5 in.), 212 mm. (8.4 in.), and 235 mm. (9.4 in.) long, has a rounded spatulate hinder edge. Unfortunately, the American Museum does not contain specimens of the louse-fish for comparison. How large *Phtheririchthys* grows is not known, but Günther remarks that the largest in the British Museum Collection was 16 inches long.

Fig. 1.—A Tahitian outrigger canoe similar to those used by the native fishermen of Tongareva and Atiu

Fishing for the Oilfish

NATIVE METHODS OF DEEP-SEA FISHING FOR *RUVETTUS PRETIOSUS* AT ATIU, HERVEY GROUP, AND ELSEWHERE IN THE SOUTH SEAS

By CHARLES B. NORDHOFF
Papeete, Tahiti, French Oceania

IN the hope that what little I have picked up about fishing for the oilfish, *Ruvettus*, may be of interest to others, it is a pleasure to bring together and to record in NATURAL HISTORY some of my notes on the hook used and the method of taking this fish. What I have to say is the result of my own observations or of conversations with native informants for whose reliability I can vouch.

It is known that *Ruvettus* is caught in Japanese waters and in the Banda Sea, and there is some reason for believing that the peculiar technique of this fishing throughout the South Seas reached there by way of Micronesia. Possibly it came eastward through the Carolines to the Gilberts, thence south to the Ellice Group, next southeastward to Samoa, to Tonga, to the Cook Islands, and the Austral Group. Furthermore, this peculiar method of fishing is practiced in islands or groups of islands lying roughly between the meridians of 150° and 170° west longitude. In the Hawaiian Islands on the north, there was formerly fishing for a fish called *walu*, (now known to be *Ruvettus*) with a hook very like the peculiar one presently to be described. Farther south the same fish is known as the *palu*, and today its fishing plays an important part in the lives of the native inhabitants of Puka Puka (Danger Island), of Penrhyn (Tongareva), Rakahanga (Rierson Island), Manihiki (Humphrey Island), of Atiu and Mangaia in the Herveys, and of Rimatara and Rurutu in the Australs. It is well known that Rurutu and Atiu men introduced this fishing in Tahiti not many years ago, and an old Atiu man, who was a sailor among the Paumotu atolls in the days when some of them were still quite primitive, tells

me that the natives of that group knew nothing of *Ruvettus* in the early days.

At Penrhyn Island (Tongareva), *Ruvettus* is called *vena*, a variation of its Polynesian name *uravena* or *kuravena*, and there a peculiar method of sinking the hook is used. The fisherman cuts half a dozen light sticks of wood, each a couple of feet long and having a short fork at one end. To the other end he attaches a lump of coral, made fast with a bit of pandanus fiber. The fork at the upper end is then laid over the bend of the wooden hook, which is thus carried down to the bottom, where the weight of line, hook, and bait permits a speedy disengagement. The forked stick and stone are called *ru*, and a new *ru* is required each time the line is let down. The point of the hook is called *mata*. This fishing is done in three hundred fathoms, and on dark nights. Hence the week of the new moon is the best time.

In Manihiki and Rakahanga (two atolls less than thirty miles apart and inhabited by the same people, who travel back and forth and are great *Ruvettus* fishermen), *Ruvettus* is called *palu*. This is a survival south of Penrhyn, of the northern name. The whole assembly of hook and point is called *kaupalu*, and the point *matika*. The sinker is known as *maini*, and the method of attachment is the same as that used in Atiu.

In Atiu, one of the southern Cook Group, *Ruvettus* is of great economic importance to the people, and the younger men fish for it on every calm, dark night. I have had in my household for years an old Atiu man, with whom I have had many a long yarn about *Ruvettus* fishing, so I shall go into a little more detail in the case of that island, where the methods in use are typical of southeastern Polynesia. The fish is called *kuravena*, the wooden part of the hook (made of casuarina wood) is known as *toko*, the point *matamata*. The sinker is perhaps worthy of description. The fisherman selects a few indurated coral or volcanic stones of suitable shape, and sur-

Fig. 2.—*Ruvettus pretiosus*, the oilfish—a mounted skin in the American Museum. From a four-foot specimen, weighing 24½ pounds, taken at Bermuda, December 19, 1924

prisingly large to my eyes. (Some I once weighed, out of curiosity, ran from eight to ten pounds each). He then peels off some flat strips of wild hibiscus bark, half an inch wide and more than a yard long. This bark is usually known as *more*, but the strips are called *atari*. When the hook is baited and ready to be lowered into the sea, the fisherman takes a strip of bark, makes a hard knot in one end, and splits the strip just above the knot. The other end is then passed through the split, making a noose which is pulled tight about the stone. The upper end of the bark is then given a turn about the shank of the *toko*, just above the crotch, with the end passing *under* the part attached to the stone. This hitch will hold as long as the line is taut, but lets go the moment the tension is relaxed.

The baits generally used are flying fish (*Cypselurus simus*), or *ature* (*Trachurops crumenopthalmus*), though I

fancy any small fish will do. I know one old fisherman who swears by chicken—raw, of course! The small fish, 6 or 7 inches long, are split in two lengthwise, and the backbones thrown away. It takes four such fillets, or two fish, to make one bait. The bait (known in Atiu as *araainu* or *mainu*) is lashed with thread or fine fiber to the *toko*, one piece at a time, and just under the point, which is left exposed. One piece is lashed to the inner side, one to the outer, and one each on the front and back sides, making what might be inelegantly called a "gob"—no doubt a tempting one to *Ruvettus*. My sketch will explain this clearly.

Now suppose it is a calm night in Atiu, with no moon, and, above all, no current. The fisherman goes out alone in his sixteen- or eighteen-foot out-rigger canoe. He carries no lantern or torch for this work, only his line, sinkers, hook (and a spare one perhaps), bait, fish-club of ironwood, and thread for lashing on bait. The line, more than 2500 feet of it, is done up very neatly in what he calls *potaro*—a ball which allows the line to run out from the inside. When all is ready, he drags his canoe over the fringing-reef, waits for a favorable opportunity, and pushes out through the breakers.

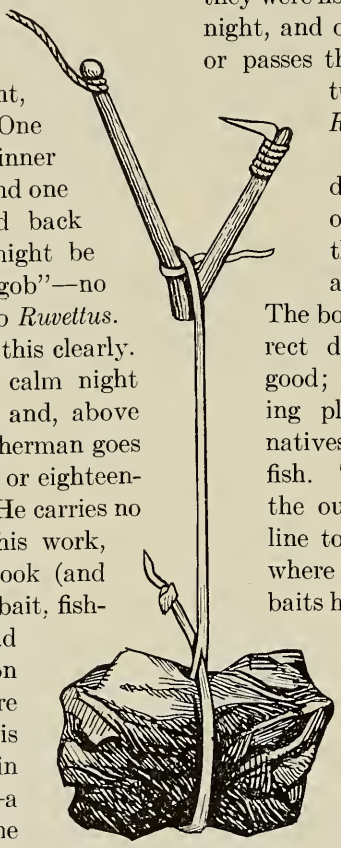


Fig. 3.—A hook from Atiu in which the sinker is held by a slip knot. When the weight rests on the bottom, the thong is automatically released. The barb itself is made of a right-angled fork of hard wood. From a sketch by the author

There is a significance in the fact that Manihiki, Rakahanga, Atiu, Mangaia, Rimatara, and Rurutu are all islands where one must push off and land in the breakers, and that, except for the two first mentioned, they are islands without lagoons. On islands with fine lagoons and passes through the reefs, I fancy the people ran more to net-fishing inside, and bonito-fishing outside, as they were always sure of getting ashore without having to brave swells which might have risen while they were fishing. The sea is calmest at night, and on islands without lagoons or passes the people would naturally turn to night-fishing for *Ruvettus*, etc.

The fisherman now paddles to a place some distance off the reef, where he knows the bottom may be reached at say four hundred fathoms. The bottom anywhere at the correct depth seems to be equally good; there are no particular fishing places (or "holes," as the natives say) in the case of this fish. The fisherman first fastens the outer end of his big ball of line to the outrigger-pole (*kiato*) where it crosses the gunwales; he baits his hook, attaches the sinker, and allows the line to run out through the fingers of his right hand until he feels the sinker strike bottom. A little more slack, and a tentative slight pull tells him that the sinker is free. All is now ready. If there is a slight current or a breath of air he takes up his paddle, holding it low down with his left hand while the haft is braced under his left shoulder, and paddles very gently with this hand, just enough to keep the line vertical. This kind of paddling is called *tamau*.

If he has no strikes at this depth, he

takes the line at water level and with a sharp graceful gesture raises it above his head, making the movement *twice*, while his left hand takes in the slack. This raises the hook about two yards. If nothing then strikes, he raises the hook three times, and waits a little. After that he raises it four times, and so on up to six.

At whatever level he catches his first fish, he continues to fish the rest of the night. When *Ruvettus* strikes, he strikes hard, and makes four rushes so fierce that line must be paid out, before he gives up. (My old man insists on *four* rushes. Since the fisher has his ritual of 2, 3, 4, 5, 6 heaves of the line to find the feeding level, I suppose he fancies the fish has his ritual number of runs).

In addition to *Ruvettus*, the Atiu men catch with the same hook and at the same depths four other kinds of fishes. These they call *manga*, identified as *Promethichthys prometheus*, a not distant relative of *Ruvettus; hapuka*, the deep-sea grouper known as *Epinephelus quernus; utu*, ichthyologically designated *Bowersia violescens*, and *paru*, whose scientific name is *Etelis courus*. Note that the northern name of *Ruvettus* (*paru* — pronounced *palu*) is here applied to another fish caught on the same tackle.

Ruvettus undoubtedly grows to an immense size off Atiu and Mangaia; my man Monday says he has occasionally caught them so large that he had to make them fast with a bit of line and tow them ashore. The head of one was given to us, and I estimated the whole fish at 200 pounds. Monday declared that he had caught many twice this size. When a fish is hooked, the man lays the paddle in the canoe, and uses his left hand to arrange the line at his feet while the fish is brought up with the right hand. It takes a young and strong man to pull up a big fish from a depth of nearly half a mile, and do it several times in a night. It is a soaking-wet, back-breaking job, and I do not wonder that *Ruvettus*-fishing has never become popular in the Society Group. If the *Ruvettus* is small, the fisherman seizes him by the gills and breaks his back over the gunwale before taking him aboard. If larger, he is seized and then clubbed to death; and if a giant, he is made fast to the boat, clubbed, and towed ashore. His teeth are not considered dangerous. Strange to say, the release from the great pressures at which he lives seems not to affect him, as in the case of cer-

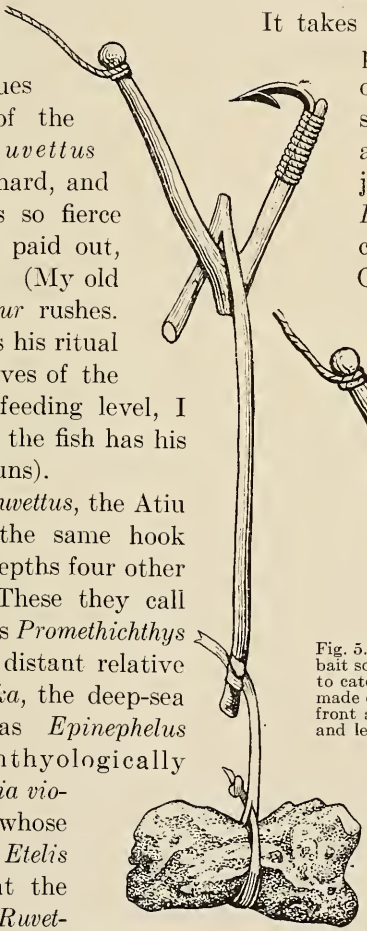


Fig. 4.—An oilfish hook from Tongareva showing the method of attaching the sinker, which is displaced when the apparatus strikes the bottom. The barb is made of the point of a European steel hook, bent to the proper angle and lashed to the top of the barb leg. From a sketch by the author

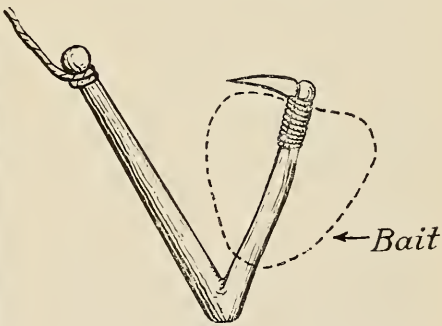


Fig. 5.—A wooden *Ruvettus* hook with the bait so lashed on as to leave the barb free to catch in the gills of a fish. The bait is made of four fillets of fish, one tied on in front and one behind, and two others right and left as described on page 42. From a sketch by the author

tain other deep-sea fish. This may be due in part to his readjustment to the decrease in pressure during his slow ascent to the surface. The lines are so long, and require so much time to pull up, that although they are valuable

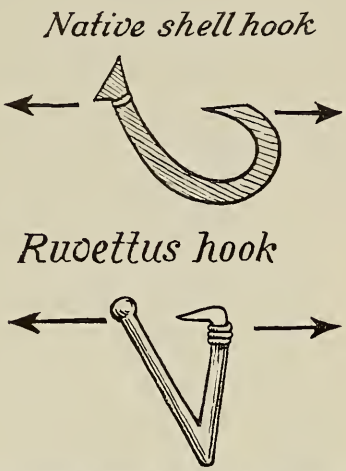


Fig. 6.—Sketches showing how a fisherman and a fish, pulling in opposite directions but in the same straight line, cause the native shell hook or the *Ruvettus* hook to become imbedded in a fish's mouth. From sketches by the author

property in native eyes, they are often abandoned, with or without a hooked fish, when the fisherman is caught in a sudden squall and has to make for shore.

As for the hook, the *toko* or hook proper is made of casuarina (iron wood), as I said. The point was formerly made of hardwood, bone, or pearl shell; today a large European hook is often used as a *matamata* (or barb), the bend opened to almost a right angle and the shank lashed to the *toko*. Another favorite *matamata* is made from the heavy wire handle of a kerosene-tin, bent and filed to a point. I never heard of a one-piece hook. They stick to the *toko*, I think, because sufficient bait could not be tied to a white man's hook, and what is more, I fancy that the native outfit will hook a larger percentage of strikes—a most desirable feature with 400 fathoms of line to pull in before rebaiting. In my opinion, the Polynesian incurved hook, of which our *Ruvettus* tackle is but one example, is mechanically superior to hooks of our kind, for when the fish strikes and begins to pull, the line and the point of the hook fall into alignment, tending to imbed the hook deeper and deeper in the fish's mouth, as is shown in the subjoined sketches.

As for lines, the old native hand-made line was superior in strength and lasting quality to anything that can be bought here in Tahiti today. I have one such line made by an old man who rolled it on his thigh, and in strength and regularity of "lay" it verifies all that Cook said in his remarks on Tahitian fishing-lines.

Ruvettus is found off practically all the South Sea islands—atoll and volcanic alike—where the requisite depth is reached. The atoll-dweller, where the reefs fall off abruptly to great depths, will find such depths a few hundred yards from shore. However, in the case of certain mountainous (volcanic) islands where the underwater slopes are more gradual, the fisherman has to go much farther out, possibly miles, before he finds the requisite depth. Here of course he is in greater danger from squalls, especially if he has caught a *Ruvettus* so large that it has to be towed ashore. Hence it is clear that with other edible fishes closer at hand and in abundance off high islands, *Ruvettus*-fishing will not be so favored as on coral atolls.

Natives say that *Ruvettus* should be cooked in the ground-oven on two or three successive days before it is eaten, and that a liberal sprinkling of lime juice improves the flavor and tends to nullify the ill effects of eating too much of this fish. And one is warned

not to suck the bones. The flesh is white, with a faint yellowish tinge probably due to the oil; is tender, flaky, and of fine flavor. It is particularly welcome in the tropics, where the flesh of practically all the surface-dwelling fish is dry. When the fish is boiled, a considerable amount of oil rises to the surface of the water. The celebrated effects of eating *Ruvettus* are somewhat exaggerated, but the fish is so good that one is likely to eat too much of it, when of course the purgative consequences are bound to be felt.

EDITORIAL NOTE

Our chief authority on *Ruvettus*-fishing is Louis Becke, whose books on the South Seas are based on years of experience as traveler and trader throughout the whole equatorial Pacific. Becke's first contribution is found in the late E. R. Waite's article on the fishes of Funafuti atoll, Ellice Group (*Memoirs Australian Museum*, 1897, Vol. 3, pp. 199–201). Here he describes the wooden hook, the line of 4– or 6–plait coconut fiber, and the stone sinker of from 4 to 6 pounds. The fishing is done on calm, dark nights, with a flying fish bait, at depths of from 150 to 200 fathoms, and in the strictest silence. In the same series of papers Charles Hedley ("The Ethnology of Funafuti," *Memoirs Australian Museum*, 1897, Vol. 3, pp. 272–276. figs.) describes the hook and its distribution at some length, and quotes a Mr. Jack O'Brien of Funafuti as to the actual manner of hooking the fish.

> ". . . the bait was a whole fish split and laid scales to scales on either side of the barb. In bolting this, the *palu*, whose jaws are very thin and pliable, gets the barb caught behind the angle of the jaw. Sometimes when the fish bites, the line is so jerked as to bang its head with the flat stone used as a sinker."

Stirred by these two articles, Augustin Krämer, published an article "Der Purgierfisch der Gilbertinseln," (*Globus*, 1901, Vol. 79, pp. 181–183. 3 figs.). He gives little new information, merely emphasizing that it is taken in deep water (about 300 m.) at the time of the new moon, on the typical large wooden hook. Krämer's article has largely to do with the purgative action of the oil, a subject on which all the available data has been brought together by E. W. Gudger—("A New Purgative, the Oil of the Castor Oil Fish, Ruvettus." *Boston Medical and Surgical Journal*, 1925, Vol. 192, pp. 107–111. fig.).

However, up to the time of publication of Mr. Nordhoff's article, the best and most complete account of fishing for *Ruvettus* is found in Becke's *By Rock and Pool on an Austral Shore*, (London, 1901, pp. 148–158), where accounts are given of this fishing as carried on at Nanomango, Ellice Group, and elsewhere. Becke declares that the night must be moonless and windless; that the large wooden hook, attached to a 4– to 8–strand coconut cinnet line, is baited as described by Mr. Nordhoff, that it is sunk to a depth of one hundred or more fathoms by a 3– or 4–pound coral stone sinker tied to the hook by a thin piece of bark readily broken when *Ruvettus* bites and hence left behind. Four men man the canoe and lower lines, one, however, paddling with one hand to keep the canoe from drifting—all in the utmost silence.

When hooked, the *palu* offers considerable resistance, but soon gives in and, except for the hauling in of his weight and that of five hundred or six hundred feet of line, is easily landed, if not caught and bitten in half by a hungry shark. The longest fish seen by Becke was 6 feet 10 inches over all; another "heavy-set" specimen had a girth of 40 inches, while his heaviest fish weighed 200 pounds.

From this it will be seen that Mr. Nordhoff's article, written twenty-five years after Becke's and Krämer's accounts, absolutely corroborates these men in every essential point. Mr. Nordhoff has made a valuable contribution to our knowledge of *Ruvettus*-fishing in the South Seas.

For complete data on the structure, variations, and distribution of the *Ruvettus* hook, the interested reader is referred to a monograph by E. W. Gudger, "Wooden Hooks Used for Catching Sharks and *Ruvettus* in the South Seas," etc. *Anthropological Papers*, American Museum Natural History, 1927, Vol. 28, pp. 201–348. 92 text-figs.

ZANE GREY AND HIS *MAKO* WHICH WEIGHED 278 POUNDS

The "Fisherman," Mr. Grey's yacht, off Whangaroa, New Zealand

Big Game Fishing in New Zealand Seas

By ZANE GREY
Patron of the American Museum

MY first fishing trip to New Zealand (1926) was in the nature of a pioneer expedition. The game was new there, and methods and tackle crude in the extreme. We anticipated criticism and opposition, and we certainly got it in plenty. The English anglers were slow even to consider American tackle and methods, let alone to adopt them.

The results of this trip, however, justified our venture and rewarded us beyond measure, and we had the satisfaction of winning a number of New Zealand anglers to our methods. We secured five world records, two of which were phenomenal. Here follows a partial summary of our catch; and the large number we think is justified owing to the desire of the New Zealand Government that we catch and identify and photograph fish, to attract the attention of the scientific and angling world to these new waters.

SOME RECORDS OF THE 1926 EXPEDITION

Captain Mitchell took two black marlin (*Makaira marlina*) of 685 and 976 pounds (the latter the world's record); 21 striped marlin (*Marlina mitsukurii*) ranging from 192 to 350 pounds and averaging 259½ pounds; 3 yellowtail (*Seriola dorsalis*) of 70, 75, and 80 pounds, averaging 75 pounds; and 6 *mako* (*Isurus* sp.) varying from 180 pounds (two specimens) to 299 and averaging 236 pounds.

I took, among other fishes, one broadbill swordfish of 400 pounds—the first *Xiphias gladius* ever caught with rod and reel in New Zealand waters; one black marlin of 704 pounds; 41 striped marlin, ranging from 168 (the only specimen below 200 pounds in weight) to 450 pounds (the world's record) and averaging 268½ pounds; 17 *mako* ranging from 56 pounds (the next smallest being 115) to 300 and averaging 190 pounds. Among other of my catches was a yellowtail of 111 pounds—another world's record.

This extraordinary fishing (surely never surpassed in the angling history of the world) explains why we (Captain Mitchell, my brother R. C. Grey, my son Romer, and I) were all so desirous

R. C. Grey standing beside his 386-pound striped marlin swordfish

of making a second trip in 1927. We did make this trip, as the following account tells in part, but owing to forty-two days of storm we did not equal our first experience.

SOME FISHES FROM THE 1927 EXPEDITION

The strangest and biggest fish we captured on our second expedition to New Zealand waters was a thresher shark (*Alopias vulpes*) of 640 pounds, incidentally the largest ever taken on rod and reel. But I cannot claim the record because, though I got the strike and hooked the fish, I mistook it for a common shark and handed the rod over to my son Romer.

We were fishing off Stevenson's Island, outside of Whangaroa, where some miles off there is a submerged reef of large area. In 1926 Captain Mitchell and I fished this location and also the Cavalli Islands, where I was the first to land a swordfish. Both places have since become popular with anglers. These are indeed magnificent fishing waters. During the summer great schools of *kahawai* and *crevallé* feed there on the surface at certain hours of the day. While feeding, one of these schools will make a rushing noise like the tumbling of a brook over stones. At such times swordfish, *mako* and other sharks abound.

The thresher shark is one of the rare fish of the seas. At Catalina I have had several follow a trolled bait. They stuck their long tails out of the water and struck at the bait with them. Of all strange weapons that have evolved upon fishes of the seas, I think the tail of the thresher is the strangest. If his body is nine feet long, his tail will be ten. When swimming, he can look backward and upward at the tip of this tail and strike very accurately with it, since his eyes are situated almost on the top of his head. He makes one think of a prehistoric monster that has survived to the present.

Three threshers have been caught at Catalina in twelve years—all small ones, around 300 pounds each. Each one was hooked through the tail. They had snagged themselves on the hook while striking at the bait. In New Zealand threshers are caught

pretty often, and run fairly big. Often they leap like greyhounds of the sea, a most unusual and wonderful spectacle. And they are hard-fighting fish.

This 640-pound one that I ran on to in New Zealand, fooled me in the strike. He had not shown on the surface and his bite was nothing much to speak of. But he felt heavy and slow, like a *reremai*—a ground or sand shark—so I gave the rod to my boy with the remark: "Here, Romer, see how quickly you can lick this fish."

Now Romer is a husky lad and has had some luck with big fish. As all boys do, he brags a little. Sometimes seeing me or Captain Mitchell or R. C.[1] in difficulties with a big fish he is prone to remark: "Say, it takes you a long time on that fish. Pull his head off. I could!"

However, Romer met retribution in this thresher. For the first hour he could do nothing with the fish. Meanwhile R. C. came up and made remarks. "Why don't you pull him up? You're weak in the back, boy. We can't hang around all afternoon."

Then Captain Mitchell ran up in his boat: "Hey, Romer, what're you on? We're mighty curious to see if you can lick him." And I said: "Son, for a boy who's a sprinter and who aims for football, you are sure slow as an angler."

Altogether—for the boatmen and his pal, Johnny Shields, got after him too—we made him see red. It really was a mean trick. But Romer himself sometimes plays mean tricks. However, he worked on that fish as he had never worked before on anything—and he has fought some pretty good battles.

At the end of two hours he had the thresher stopped, and in another hour and a half he had him whipped. Really he gave a magnificent exhibition. He blistered his hands, lamed his back, and ruined my rod, but he whipped the thresher.

Capt. L. D. Mitchell with his 976-pound black marlin swordfish

When the great fish came up so we could see him, I certainly sustained a shock—and I have seen a great many remarkable sea-creatures come up out of the deeps. He was a huge, grotesque, frightful, and terrible fish to gaze

[1]My brother R. C. Grey.

ZANE GREY CONGRATULATING HIS SON ROMER ON THE CAPTURE OF THE 640-POUND THRESHER SHARK

upon. All my fishing years I had longed to catch a great thresher. Here I had struck one—a record—and had turned the rod over to my son! The joke was on me.

The thresher must be classed as a game fish. He fights deep most of the time and is exceedingly stubborn. Comparing him with the *mako*, he is pound for pound a harder fish to whip.

The *mako*, however, is the aristocrat of all sharks. It is really unfitting to call him a shark at all. I seldom use the word with regard to him. And after he attains some weight—say over 400 pounds—he is indeed a magnificent sporting fish. His leaps are prodigious, inconceivably high above the water. The ease and grace of this leap is indescribable. It must be seen. He comes out slick, glides up, turns a somersault, and goes down head first, like a diving gull, almost without a splash. Then instantly he is out again. Seldom does a *mako* leap once only. I have had one go up six times—a most thrilling sight. His third leap is always the highest.

The *mako* seems to be known only in New Zealand and Japanese waters. He attains huge size, up to 2000 pounds. Captain Mitchell hooked one in 1926 that leaped twice—the first time scaring us nearly to death, and the second giving us time to judge his weight fairly at around 1200 pounds. Needless to state here, that *mako* is still roaming the sea. Some day, though, we will catch one that large or even larger.

We caught two black marlin in New Zealand waters in 1927, both small fish—340 and 380 pounds. Quite a comedown from our 1926 fish of 704 and 976 pounds. However, the capture of any black marlin is an event to be proud of, and 1927 was a bad season because of rough waters. Captain Mitchell's fish, the larger of the two, leaped out of the water as the captain was winding in the bait, and nearly landed in the boat. The fish was after that bait and he got it. Then he gave

The thresher shark looks like a prehistoric monster

a grand exhibition of fighting on the surface. My black marlin, 340 pounds, charged my "teasers" and bait, and certainly committed suicide.

It is my opinion that fishes of this species do not like rough water, as the striped marlin do. During three months, I had hold of only one, besides that which I caught. I saw this fish heaving up behind my bait and he sure was big. He took it and I struck at him, but—alas!

We saw a very large black marlin, surely a 1000-pounder, riding the swells. It was in shore near the entrance to the Bay of Islands, on the way to my yacht at the close of day when we had no good bait. I put on the only one there was—a *kahawai* stiff as a poker.

We followed this marlin—all three boats—and the closer we got to him as he rolled up in the swells the louder we yelled. If I had known then that we were going to see swordfish in the South Seas twice as big as this one, I might have saved my breath. But there are lots of things we do not know until they happen. Anyway when I got my bait in front of this marlin and he sheered off after it, I nearly had a fit. He refused to take it. We followed, and made careful approach to drag the bait again before him. He came to it and swam clear round it. We were sure he would bite. He did not. Then I did have a fit.

My brother, R. C., struck a striped marlin off the Cavallis which gave perhaps the greatest surface exhibition I ever saw. This fish was one of the long slim ones, as marlins go, but he was so swift in his leaps that we could not train the cameras on him, and so strong that R. C. could just barely stay with him by running the launch full speed.

It was bright sunlight, with just a ripple on the dark blue sea. The marlin blazed in the air, green on the back, striped across his silver-white sides. He cracked the water like pistol shots; he made every kind of a splash, from a thin cutting of spray to a great, angry, boiling maelstrom. The beauty and wonder of such spectacular acrobatics must be seen to be believed and appreciated. Especially must the magnificent fury or fright of this tiger-species be seen. It cannot be adequately described. This marlin weighed 368 pounds, and comes next to my record (450) of 1926.

The Shepherd Fish and Its Strange Pasture Lands

THE REMARKABLE ASSOCIATION BETWEEN THE FISH, *NOMEUS*, AND THE PORTUGUESE MAN-OF-WAR, *PHYSALIA*

By G. H. PARKER
Director of the Zoological Laboratory, Harvard University

FOR a small fish the open sea is a habitat fraught with endless danger. Here he may become the prey of anything that can swallow him; he may be chased and eaten by the larger members of his own tribe; he may be snapped up and swallowed by such sea mammals as the porpoise or the dolphin; and he may be caught by diving birds and carried off as food for their nestlings. Almost nowhere is there safety. A floating bunch of seaweed, a box or a barrel, or even a piece of driftwood may afford a temporary refuge for him that at any moment may prove of vital importance. Around such an obstacle he may successfully dodge his huge pursuer, and in the interior of a mass of weed or of an empty box he may find a sanctuary as secure as a hollow tree for a land animal. Every collector of pelagic fishes knows the meaning of this habit, and, when he is on the open sea in search of small game, he steers for every floating object he sees, scoops it in with his collecting net, and is usually rewarded by a catch of small fry. When we think of the immense waste of oceanic waters with their relative freedom from floating material, we can appreciate to some degree the slim chance for self-preservation that a small fish has. No wonder that he uses every opportunity within reach as a protection against his voracious enemies.

But not everything that floats in the sea is a haven of refuge for the small fish. Whoever has been stung by a jellyfish knows that it is far from being a protection to any creature. Jellyfishes belong to a large group of animals that embraces a great variety of sea creatures including such forms as the corals, sea pens, sea anemones, Portuguese men-of-war, and the like. All these are provided with nettling organs which are best developed on their tentacles and similar parts. These nettling organs serve the double purpose of stinging invaders and thus driving them off, and of killing other creatures that may serve as food. In a number of these stinging animals, as for instance in our common sea anemones, the nettling organs, though present, are so weak that ordinarily they can make no impression on the human skin. Hence we look upon such forms as innocuous. But in others, as for example in the majority of the jellyfishes, the nettling organs are well developed and may inflict upon man not only a severe and painful injury but may poison him so seriously that it sometimes takes weeks for him to recover. Notorious among these more severely injurious kinds is the Portuguese man-of-war, *Physalia*. The tentacles of this jellyfish, if passed over the skin of a human being, may inflict such a vigorous urtication as to throw the person into spasms and leave him in a prostration that may last for many days. This particular species is commonly regarded as the one whose sting is the most vigorous of all marine animals. Both in immediate painfulness and in after effects it is quite comparable to the results of being stung many times by bees or wasps or by a scorpion.

The means whereby a jellyfish or other like animal can sting is of microscopic proportions. The nettling organs of these animals are to be found commonly upon the tentacles that surround the mouth or that hang from the edge of the bell. Such organs appear usually as small swellings on the surface of the tentacle. When these swellings are examined under the microscope, one sees that they contain multitudes of microscopic capsules within each one of which is a spirally twisted filament. If the skin of a fish

The Portuguese man-of-war, *Physalia*, sheltering several shepherd fish, *Nomeus*, amid its tentacles, which bear myriads of nettling organs. Photograph of a model in the American Museum

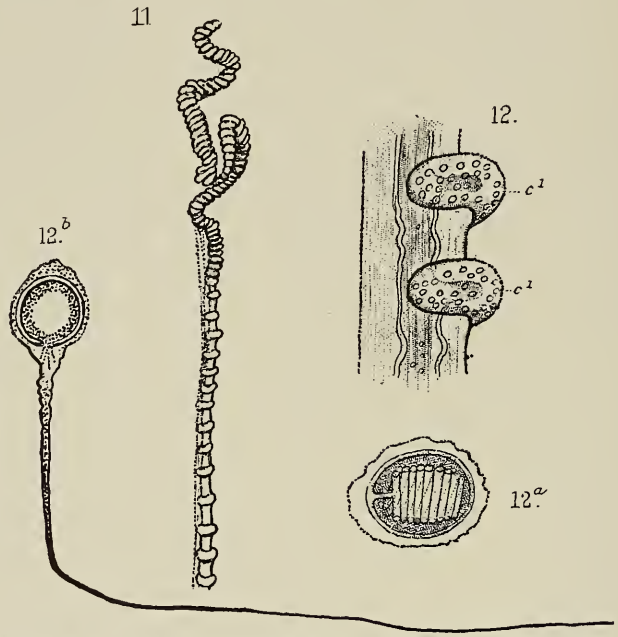
or of a human being comes in contact with a nettling organ, thousands of these minute filaments are shot out and in a very remarkable way penetrate the skin of the creature concerned. Each filament is a hollow tube of extremely fine caliber whose cavity leads into that of the capsule from which the filament has emerged. Through this microscopic tube the minute amount of poison contained in the capsule may be injected into the wound inflicted by the filament itself. Each filament, with its attached capsule, is in fact a microscopic hypodermic syringe which, after insertion under the skin, may continue to inject poison into the creature whose misery or death it may thus bring about. A person stung by a jellyfish is punctured by myriads of such microscopic syringes, each one of which is forcing its irritating contents into the wound produced by its needle. In most jellyfishes these organs of torment are of such a size as to be visible only under the high power of the microscope, but on the tentacles of the Portuguese man-of-war the nettling organs are so large that, when their filaments are discharged, these organs seem to be covered with a fine woolly growth easily visible to the naked eye. The nettling filaments of this jellyfish are in all probability the largest of their kind, and the pain and wounds that they inflict are dreaded by all those who have occasion to touch them.

The Portuguese man-of-war or *Physalia*, as it is technically called, is a native of the warmer waters of the Atlantic and the Pacific oceans. Each *Physalia* consists of a gas-filled sac which floats on the top of the water. From the underside of the sac long purplish tentacles trail a dozen feet or more into the sea. In addition to these tentacles the underside of the sac carries innumerable trumpet-shaped mouths that hang down an inch or so into the sea-water below. The long tentacles are the parts on which the very vigorous nettling organs are situated. The sac or float to which all these parts are attached maintains its position like an inflated bladder on the surface of the water. This float is glassy-clear in its transparency and is tinted in varying shades of blue, purple, and pink. One end of it is pointed, the other is blunt, not unlike the hull of a vessel. The upper part of the float rises into a high, fluted crest, giving the whole the appearance of an ancient galleon under full sail. Nothing is more beautiful than to meet a flotilla of these miniature, brightly colored barks making their way under a gentle breeze across the surface of a tropical sea. They rise and fall with the waves and stand to the wind with such regularity and precision that they recall in a most realistic way a miniature reproduction of the ancient fleets of Spain or of Portugal.

In the blue waters below their diminutive hulls, the long, delicate tentacles with their deadly nettling organs stream out many feet like anchor lines. Almost transparent and of the tint of the blue sea water itself, one of these tentacles may be struck by an unwary fish. Instantly batteries of nettle capsules are discharged with the double result that the fish is made to adhere to the tentacle at the same time that it is seriously poisoned. Its struggles excite the tentacle to shorten and thus the victim is drawn up nearer to the clusters of sucking mouths. Its movements, moreover, bring it into contact with other tentacles, in this way making its capture doubly certain. Sooner or later the fish, if not

too large, is entirely overcome by the poisonous injections and is drawn up to within range of the numerous mouths which spread their trumpet-shaped lips so generously over the benumbed prey as to cover it entirely. Digestion proceeds in this semi-external position and the resulting juices and fragments of the partly digested fish are sucked up by the mouths and elaborated as food for the man-of-war as a whole. It is not unusual to find Portuguese men-of-war with the remains of several partly digested fishes still held to the underside of the float. Sooner or later these are cast off, for the jellyfish certainly catches many more fishes than are necessary for its food.

Could a Portuguese man-of-war be improved upon as a device to catch small creatures in the open sea? As a floating object it naturally attracts fishes in consequence of the protection it appears to promise. But long before they reach it they may collide with one of its numerous tentacles which, as already explained, are arranged to kill, hold, and transport to the mouths any fish of reasonable size. Even the struggles of the fish increase the certainty with which it will be brought to its end. Thus in all respects the Portuguese man-of-war is an admirable death trap for small fishes.



Details of tentacle and nettling organ from the Portuguese man-of-war. No. 11—a slightly magnified portion of a tentacle showing the transverse swellings. No. 12—two of these swellings enlarged to show the embedded poison capsules (c′). No. 12a—one of the undischarged capsules (c′) with its coiled thread, greatly enlarged. No. 12b—one of the discharged capsules with its extended filament. Redrawn from Huxley (*Oceanic Hydrozoa*, 1859, pl. X).

Notwithstanding the deadly nature of the *Physalia*, there is to be found under its float and in among its poisonous tentacles a small fish, the *Nomeus*, which lives in this situation with apparent impunity. This fish is found

commonly only in association with the man-of-war. There is no obvious reason against its independent occurrence in oceanic situations but, as a matter of fact, when it is not taken in immediate association with a man-of-war it is not far separated from the jellyfish, and in regions where its occurrence is periodic it comes and goes with this particular form. The species of *Nomeus* that is thus associated with the *Physalia* has been reported from the Indian Ocean as well as from the warmer parts of the Atlantic Ocean. Its maximum length is about four inches. In consequence of the large black patches on its body and of its pair of broad, fan-shaped ventral fins it is by no means inconspicuous. The most ready way of obtaining it is to dip up with a large net any Portuguese men-of war within reach; under many of these one or more *Nomeus* may be taken. They often show considerable range in size and as many as ten have been reported from a single *Physalia*. The most remarkable peculiarity in the whole situation is that though other small fishes in the same locality as *Nomeus* would quickly meet with death, this fish finds its environment among the tentacles of *Physalia* so favorable that, as already explained, it is seldom found elsewhere.

This little fish was first described by Gmelin in 1788 under the name of *Gobius gronovii* in honor of Gronovius, a senator of Holland and one of the ablest students of fishes in his day. The name was changed in 1817 by the great French naturalist Cuvier to *Nomeus gronovii*. In Homeric Greek *nomeus* is the shepherd or pastor and the latter name is often applied as the common English designation for the fish. Why Cuvier should have chosen the name *Nomeus* for the fish is difficult to conjecture. As a matter of fact these little fishes are more like a herd of sheep than is any one of them like a shepherd. It is probable that Cuvier's employment of the name is a loose use of language. But however this may be, the pasture land of *Nomeus* is certainly a remarkable one, for it is the region circumscribed by the tentacles of *Physalia*. In this relatively limited space much of the life of *Nomeus* is passed, a space in which apparently no other kind of fish can easily live.

What are the mutual relations of *Physalia* and *Nomeus* that this association of the two forms should be maintained? The answer to this question can be at best only conjectured. The presence of *Nomeus* among the *Physalia* tentacles probably induces other small fishes to enter the deadly territory and thus helps in providing *Physalia* with an abundant food supply. More or less of this supply in a partly digested condition falls to the share of *Nomeus*. But the chief advantage of the combination that accrues to the fish is the possession in the open sea of a territory peculiarly its own. No other inhabitant of the ocean can trespass on this strange pasture land without danger to its life. How *Nomeus* accomplishes the invasion so successfully is unknown. Is the fish immune to the deadly poison of the *Physalia* or does its skin contain a substance that prevents the discharge of the nettle capsules of the jellyfish? These and other like questions can be answered only by a further study of *Physalia* and *Nomeus*.

A Barn-door Skate (*Raja stabuliforis*) with Abnormal Pectoral Fins

By LEWIS RADCLIFFE
Deputy Commissioner, U. S. Bureau of Fisheries

THE strap-gilled fishes (the Elasmobranchii), so called because they lack the gill covers of our bony fishes and have the gill openings separated by "straps" of skin and flesh, are divided into two groups, the sharks and rays. In typical sharks the body is spindle-shaped, there is a pointed head with laterally placed gill-openings, and a well developed caudal fin which serves as the chief organ of locomotion, while the pectoral and smaller pelvic fins serve chiefly as balancers. In the typical rays the head and body are greatly depressed, the gill openings are on the under surface, while the pectoral fins are markedly expanded, and have become the chief organs of locomotion, the tail and fins being much reduced. Such forms are adapted to a life on the floor of the ocean.

Between the representative forms of the two groups just described, are intermediate types which practically bridge the gap. For instance, the angel sharks (Squatinidæ), of which *Rhina squatina* (Fig. 1) is an example, fit in admirably here. *Rhina* is raylike, with a broad flattened body, a terminal mouth, with pectoral fins larger and more expanded than those of a shark but not nearly so large as those of a ray and separated from the head by a distinct notch. Its gill openings are partly lateral, and its dorsals, placed rather far back, are smaller than a shark's, but much larger than a ray's. And finally, the caudal fin is, like the other organs, intermediate in type. *Rhina squatina*, as the figure shows, is a shark plainly on the way to becoming a ray.

Other raylike sharks (more raylike than the preceding) are the saw-fishes (Pristidæ), which are commonly classed as rays because the anterior part of the body is depressed, the mouth and gill openings inferior, pectoral fins continuous with the head in front (lacking the notch found in *Rhina* between the front margin and the head) but with a well-developed sharklike tail. Still less sharklike are the guitar-fishes (Rhinobatidæ). They have the body deeply depressed anteriorly, with inferior mouth and gills as in the preceding group, but with the pectorals placed far forward and definitely confluent with the prolonged snout—markedly raylike in these anterior parts. Posteriorly the tail is still sharklike, but somewhat flattened and having a prominent fold of skin on each side.

The transition to the skates (Rajidæ) is marked by a greater lateral expansion of the body and pectoral fins to a rhomboidal shape. The pectorals, which extend to but not around the snout, represent practically the only organ of motion. The pelvic fins are poorly developed, the caudal region has become a slender tail, and the dorsal fins are placed near its tip, in most forms. Finally, in the last and most specialized of the rays (*Disceus*) the body is extremely flattened and the pectoral fins meet and fuse not merely before but practically behind—encir-

cling the body and making it disc-shaped.

If, then, the skates are elasmobranchs of a more highly specialized type than the sharks, their early embryos must go through a shark stage in their development. That this is true is well known to embryologists, less so to zoölogists in general, and not at all to the public at large. One of the most interesting things found in baby skates is that, as they "climb their own ancestral tree," their pectorals are first of the typical shark-fin form, free from the head anteriorly. As development proceeds, the fin grows anteriorly faster than fusion takes place with the head laterally, but this fusion proceeds steadily, and finally the pectorals become confluent with the head as is found in the normal skates and rays.

However, development (fusion, etc.) does not always take place uniformly and normally, and occasionally skates are taken in which the fusion of the pectoral fins and the head has never been completed, giving the animal a very grotesque appearance. While such teratological forms are not common, they are not unknown, and a number of accounts are found of cases of such abnormalities.

In 1924 an abnormal skate of this kind was taken at the Bureau of Fisheries Laboratory at Woods Hole, Massachusetts. On careful study this proved to be a young specimen of the barn-door skate (*Raja stabuliforis* Garman). This species is common in the Gulf of Maine, and is our largest skate, reaching a length of six feet or more. This teratological specimen (Fig. 2 herein) is an immature male, the measurements for which are as follows: total length 20.5 in.; length, tip of snout to tip of ventral fins 11.75 in.; length of tail from hinder margin of vent to tip 10.25 in.; length of head from tip of snout to a line joining the bases of the right and left notches 5.25 in.; tip of snout to bottom of right notch 5.5 in., to base of left notch 5.25 in.; width of base of head at notches 3.2 in.

From these measurements it will be seen that the fish is slightly asymmetrical in its abnormality—the right notch being deeper than the left as

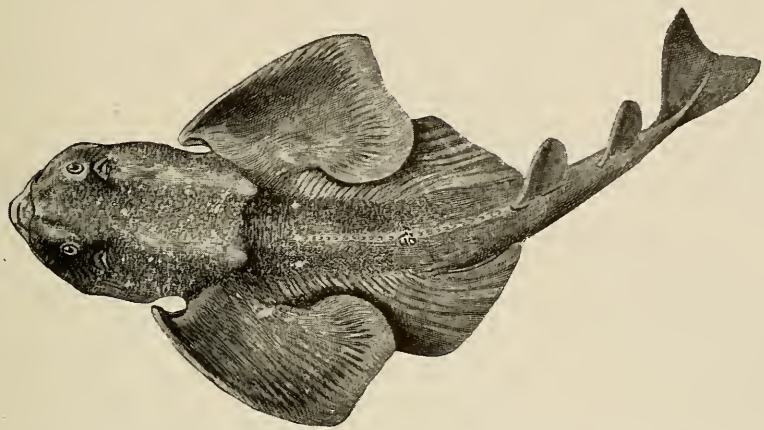


Fig. 1.—The angel shark, *Rhina squatina*. Note the notch between the pectoral fins and the head. After Boulenger, 1904

may be seen in Fig. 2 (dorsal view). Turning now to the ventral surface (Fig. 3), it will be seen that this later abnormality results also in an abnormal

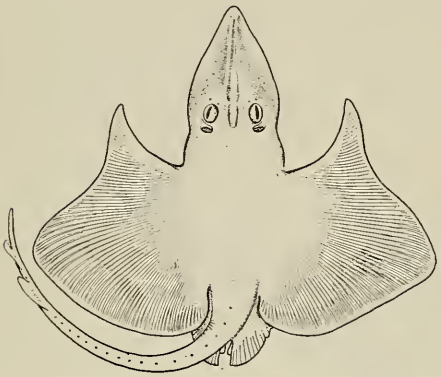


Fig. 2.—An abnormal specimen of the barndoor skate, *Raja stabuliforis*, from Woods Hole, Mass., in which the pectoral fins have failed to unite with the head

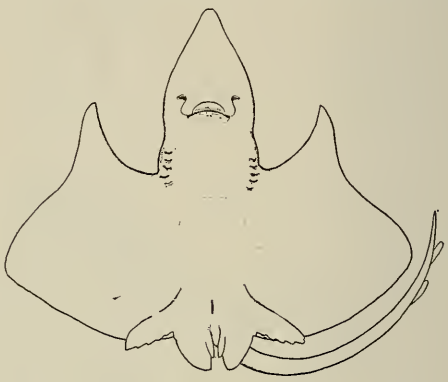


Fig. 3.—Ventral view of the abnormal *Raja stabuliforis*. Note that there are three gill slits above the notch on the right and but two on the left

placement of the gill slits—on the right side three gill slits are above or forward of the notch and on the left only two are so placed. Other than the points named (notches and gill slits) the ray seems to be normal—it is simply a young barndoor skate in which the embryonic condition, where the pectorals have not fused with the head, has persisted into its post-larval life.

This teratological condition in rays has long been known, but all that can be done here with the literature is to refer to some of the earliest accounts in which such rays were, interestingly enough, described as new genera and species, and to some later outstanding articles in which the matter has been effectually cleared up.

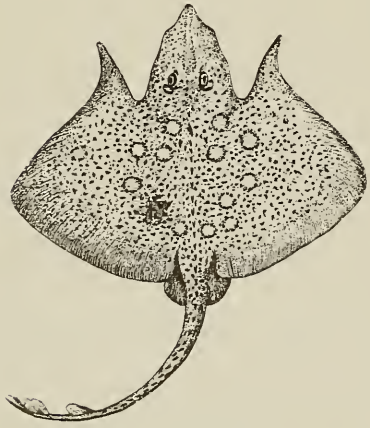


Fig. 4.—Flemming's *Hieroptera abredonensis*, a skate with the same type of abnormality as that in Fig. 2. After Flemming, 1841

The first writer to describe such rays seems to have been the Breslau naturalist, A. W. Otto.[1] In 1818, Otto, while in Edinburgh, obtained from a fisherman there the curiously shaped ray which he figured and described in 1821 as a new genus and species—*Propterygia hypostica*, (Fig. 5 herein). This figure, plainly made from a dried specimen, differs markedly from that of the Woods Hole fish. Here we have the same failure of the anterior edge of each pectoral to unite with the side of the head. But back of this there has been a splitting of each pectoral into an anterior band-shaped part and a posterior and vastly larger part con-

[1]Otto, A. W. "Ueber eine neue Roche (*Propterygia hypostica*)" etc. Nova Acta Academiæ Leopoldino-Carolinæ, 1821, Vol. 10, 113–121. 2 pls.

taining most of the fin structures. In other words, it looks as if this ray had four pectoral fins, two anterior and smaller thumblike fins, and two posterior larger hand-shaped real fins.

This specimen was a small one—only 9.5 inches over all (body 5 and tail 4.5 inches long) and 7 inches wide. The head stretched 2.25 inches beyond the point where the pectorals joined it, and was 2 inches wide at its base.

Otto knew nothing of the embryological history of rays, but he did know something of the great ray called *Cephaloptera* (*Manta*) which has projecting forward from the head two cephalic fins, and he did not fail to call attention to the rather marked similarity between his fish and it. (See Fig. 6). However, he recognized that his was not a *Cephaloptera*, and gave it the name noted above—Propterygia = fins in front of the [true] fins—to account for its rarity, and conjectured that it "lives in much greater depths of the ocean than most rays."

The next describer of a ray with malformed pectorals was John Flemming.[1] His specimen (shown herein as Figure 4) came from Aberdeen Bay in July, 1840. It was 18 inches long (equally divided between body and tail) and 13 inches wide. The head was 3.3 inches long, and its breadth 4 inches. The horns of the pectorals were each 2 inches long and 1.8 inches broad at the base. The fish was an immature female.

Since he could not assign it to any known form, Flemming erected for it a new genus and species, *Hieroptera* (priest wings) *abredonensis* (from Aberdeen). However, he recognized its affinity to Otto's *Propterygia* and to *Cephaloptera*. It is, of course, apparent to the reader from Flemming's picture that it is a ray showing the same malformation—only in lesser degree—as is found in the Woods Hole specimen.

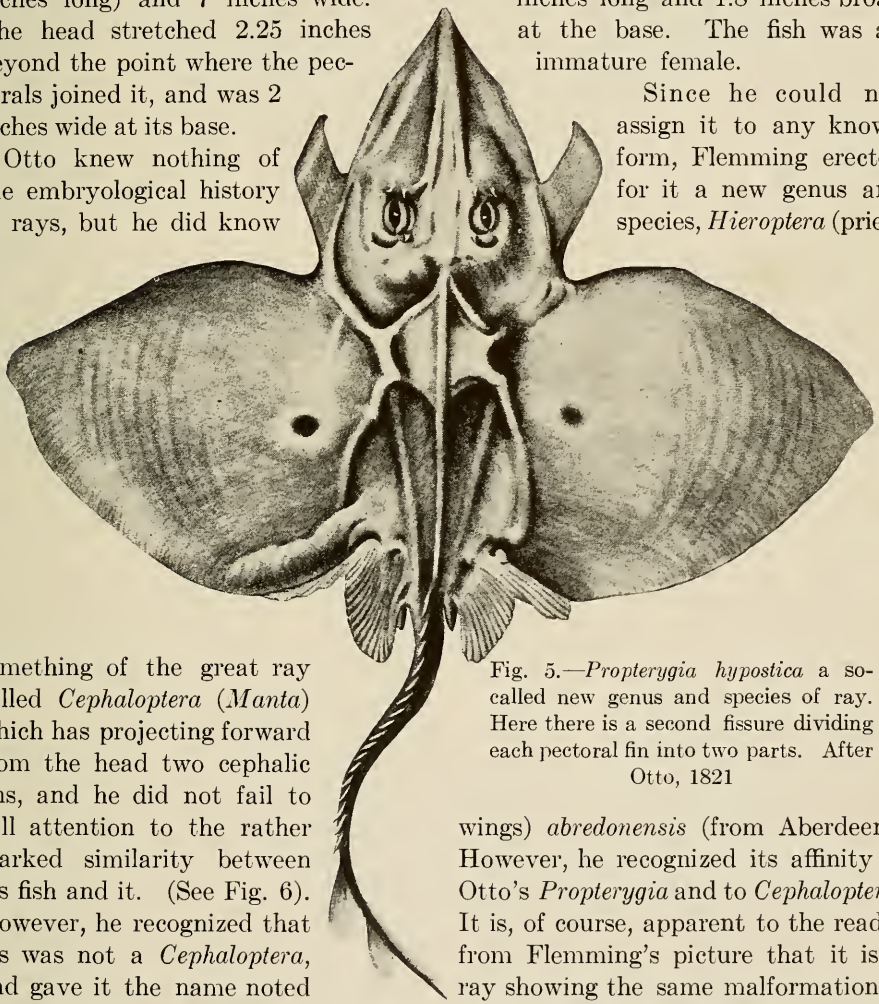


Fig. 5.—*Propterygia hypostica* a so-called new genus and species of ray. Here there is a second fissure dividing each pectoral fin into two parts. After Otto, 1821

That these rays were merely abnormal was pronounced by the two men who first systematized our knowledge of the elasmobranchs—Müller and Henle.[2] In the preface to their

[1] Flemming, John. "Description of a Species of Skate New to the British Fauna." Edinburgh New Philosophical Journal, 1841, Vol. 31, 236–238, 2 pls.

[2] Müller, Johannes und Henle, Jacob, "Systematische Beschreibung der Plagiostomen." Berlin 1838–41, preface, pp. viii–ix.

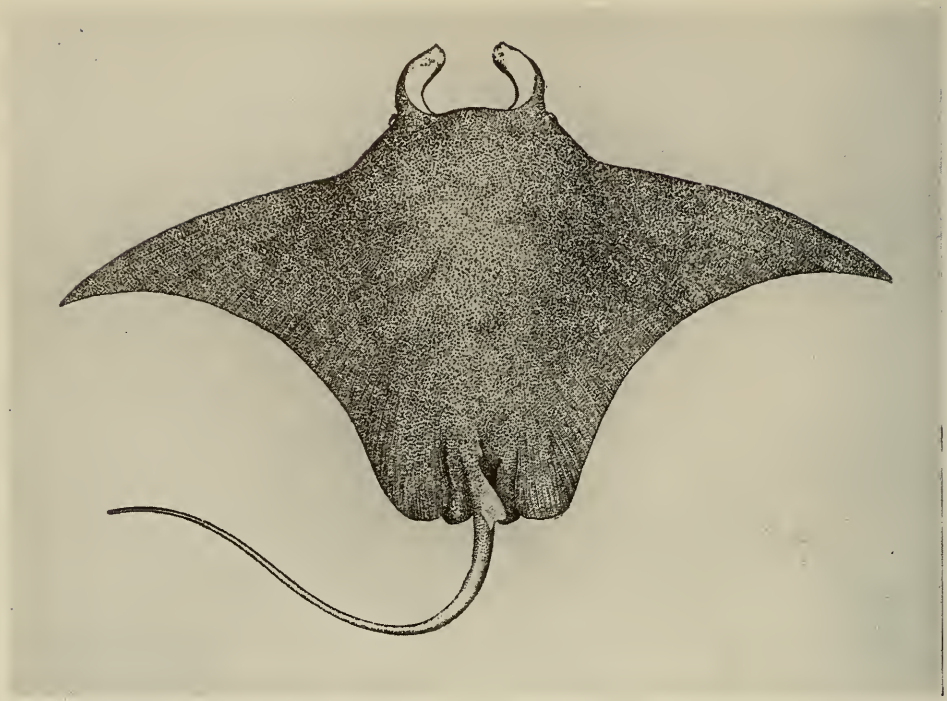


Fig. 6.—Dorsal view of the giant ray, *Manta* (cloak), akin to *Cephaloptera* (head-finned). The two anteriorly projecting cephalic fins give it the specific name *birostris* (*two-horned*). After Jordan and Evermann

book, they refer to such pathological features in rays as Otto figured and described, and say that *Propterygia* cannot be made a new genus, since it is merely an abnormality.

Müller and Henle's remarks are more or less incidental, not so, however, those of the eminent Danish ichthyologist, Lütken[1], who reviews all the literature of these abnormal rays as known to him, and comes to this definite conclusion:

As reasonable as it seemed 40 or 50 years ago that these ray-forms were special genera and species, just so clear will it appear now that they are nothing but deformities (monstrosities) and belong to one or another [well known] species of rays.

Lütken then "clinches" the matter by taking up each abnormal ray in the literature known to him, and by assigning it to a certain well-known genus and species. Thus *Propterygia* and *Hieroptera* are reduced to synonymy.

And finally, Dr. Theodore N. Gill,[2] our most critical student of the nomenclature of fishes, in discussing these and other names given to rays, settles the matter once for all in the following clear-cut statement:

There is a liability in any skate to an arrest of development in the growth of the pectoral fins forward and consequently their continuity with the head, but in most of such cases there is an independent extension forward from the base of the pectorals. Such anomalies have received generic names, *Propterygia* having been proposed for one phase of development and *Hieroptera* for another.

[1]Lütken, Chr. "Smaa Bidrag til Selachiernes Naturhistorie. (Om vanskabte Rokkeformer)." Videnskabelige Meddelelser, 1879, ser. 4, Vol. 1, 45–55. text-fig.

[2]Gill, T. N. "Notes on the genus *Cephaleutherus* of Rafinesque, and Other Rays with Aberrant Pectoral Fins (*Propterygia* and *Hieroptera*)." Proceedings United States National Museum [for 1895] 1896, Vol. 18, pp. 195–198.

As has been noted, there is a fair amount of literature dealing with this abnormality. However interesting it would be, consideration of this would unduly expand this article, and hence its study must be left to another hand. For the references, the student is referred to the *Bibliography of Fishes* (Vol. III, p. 603) by Bashford Dean, E. W. Gudger, and A. W. Henn. However, it will be of interest to bring the present account to a close by presenting the oldest known figure of this abnormality.

This is found in Ulysse Aldrovandi's huge folio, *De Piscibus*, Bononiæ [Bologna] 1613, p. 443, and is reproduced herein as Fig. 7. This figure is not original with our Italian author, but is said to have been copied from Conrad Gesner. Search has been made through all the works of Gesner available but unfortunately the original has not been found. The ray from which this figure was made has evidently been dried and artificially distorted, but it is plainly a case of *Hieroptera*—priest wings—a ray with abnormal pectorals. It seems plain, too, that such a fish is probably the original of the curious and unusual figures of monk-fishes, priest-fishes, and bishop-fishes, with which the pages of such old naturalists as Aldrovandi and Gesner, to say nothing of the lesser lights, are filled.

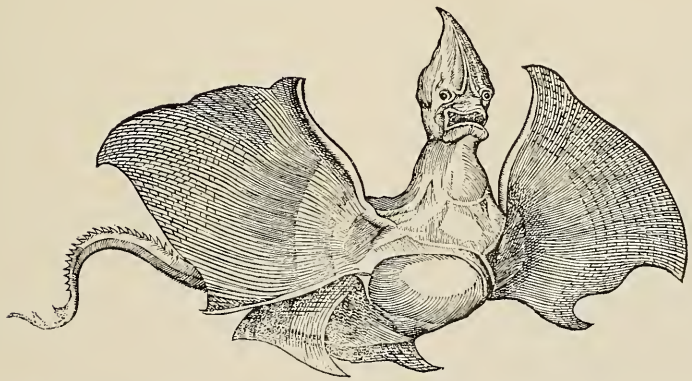


Fig. 7.—Gesner's "Spitzrogen," the earliest known figure of a ray with malformed pectorals. The artist has given pretty free rein to his imagination in making this drawing. After Aldrovandi, 1613

About Flying Fishes

By J. T. NICHOLS,
Curator of Recent Fishes, American Museum
and C. M. BREDER, Jr.
Research Associate, New York Aquarium

IT has recently been the good fortune of the writers to study an exceptionally interesting collection of flying fishes brought back by the "Arcturus" expedition of 1925, under the direction of Mr. William Beebe. A report on this collection will shortly appear in *Zoologica*, the technical series of the New York Zoological Society. Meanwhile, the readers of Natural History will, we think, be interested in various facts and problems concerning flying fishes.

The ability to indulge in more or less protracted aërial excursions is known to have arisen independently in four present-day groups of fishes, and in at least one fossil group. These groups are:

The African fresh-water flying fish (*Pantodon*), a small species related to the herring-trout group.

The South American fresh-water flying fish (*Gasteropelecus* and related genera), belonging to the tropical family *Characidæ*, which is related to catfishes and minnows.

A fossil Haplomid (*Chirothrix*), related to our pikes and pickerels.

True flying fishes (*Exocoetidæ*) a large marine family, all the members of which have powers of flight. They are related to the slender halfbeaks, billfishes, etc.

The flying gurnard (*Dactylopterus*) one of the mail-cheeked fishes, related to the sea-robins and sculpins.

Thus we see that several unrelated groups of fishes have developed independently the ability to fly. However, the true flying fishes (*Exocoetidæ*) characteristic of the trade-wind belts of open, tropical oceans, excel all others in aërial powers, and furthermore, we have here a large and varied group of aviators, not merely one or a few related species with powers of flight. It is also of interest that the flying gurnard is the only member of the great modern group of spiny-rayed fishes (*Acanthopterygii*) to have developed the fin equipment necessary to support it for even a short distance in the air. Its close relatives are bottom-dwelling fishes which lunge upward into the free water above them, and then coast down again to the bottom, with fins set. The flying gurnard's flight is somewhat analogous to this habit, the difference being that the fish leaps into the air, where its relatively large breast fins are able to support it for a short journey.

Aside from the flying gurnard, the other four groups of flyers are all less modern fishes of more primitive organization, perhaps more closely related to each other than any are to the flying gurnard.

Of the fossil *Chirothrix* we naturally know little. In this form it was the ventral fins which were most enlarged, placed anteriorly, close to the pectorals. Though it is not universally admitted that the fish was a flyer, such is the most reasonable hypothesis advanced to explain its fin development.[1] Of the African and South American fresh-water flying fishes, the former, *Pantodon*, sometimes kept in balanced aquaria, has very slight powers of flight. The South American *Gasteropelecus* is a relatively better flyer, especially con

[1]Landois, 1894, *Neues Jahrbuch Mineralogie*, Stuttgart, II, p. 228-235.

The African fresh-water "flying-fish" *Pantodon*, from a photograph by Dr. E. Bade

sidering its small size. It is said that it flaps its pectoral fins vigorously during passage through the air. The structure and muscles of this interesting form are described in detail in the *Annals and Magazine of Natural History* for 1913.[1]

With this short résumé, we will turn to a more detailed discussion of the true marine flying fishes familiar to all who venture on blue water. Their abundance and world-wide distribution bespeak the success which has come to them by invasion of that realm for the most part held (among backboned animals) by birds.

The first question which comes to mind is "Why do flying fishes fly?" Undoubtedly the chief use of flight to these fishes is that thereby they escape predaceous enemies. The rapid approach of a submerged body, such as the hull of a ship, will cause them to rise into the air and soar for several hundred yards or more. The larger species fly singly, the smaller ones frequently leave the water in a glistening silver "flock" or "shoal," and they may soar for several hundred yards or more before dropping back into their native element. To pursuing enemies, for whom the surface of the water is virtually a ceiling to be avoided, this ability on the part of their prey must be a source of considerable and frequent disappointment.

By "banking" to right and to left, flying fish can alter the direction of their course. In the daytime they are able to see where they are going, and seldom fall aboard ship. At night not being able to see, they frequently strike against the rigging and fall to the deck. The dolphin (*Coryphæna*), perhaps the swiftest fish that swims the open sea, feeds largely on flying fishes. It frequently thrusts its head and shoulders clear of the water to seize them, and will follow under water the curving shadow of a fish above with astonishing speed, ready to seize it when it descends. At the same time it is probable that most of the individuals captured by the dolphin are those which by some mischance are slow in gaining the air, or which do not

The South American fresh-water flying fish, *Gasteropelecus*, from a drawing by Dr. E. Bade

[1]Ridgewood, 1913, *Annals and Magazine of Natural History*, (8) XII, pl. 544–548, pl. XVI.

make a perfect flight. Flying fish fly much more frequently in a fresh breeze than when it is calm and in light air. Under optimum conditions they seem to do so from exuberance as well as for refuge.

A second natural question would be, "How do flying fishes fly?" This introduces a problem that has bothered naturalists, aëronautical engineers, philosophers, and others for a long time. There is today anything but unanimity of opinion on this subject. The argument as to whether these fishes sustain their flight by motion (flapping) of the wings or merely soar as gliders, has not been satisfactorily settled. There is some truth in both points of view. The flight is largely a planing one, but at certain times and under certain conditions a definite wing motion may enter in and contribute to it. The enlarged pectoral fins or "wings" are, on anatomical grounds and structurally—from an engineering point of view—ideal gliding planes, so arranged as to be easily held rigid at the proper angle. R. E. Dowd[1] has worked out the structure of the flying fish wing from an aëronautical point of view, and arrived at the conclusion that it is extremely well "designed" for planing, but not for a flapping flight.

The wings of large flying fishes are sometimes seen to vibrate or flutter, a motion more reasonably referable to tension in setting them, or to the wind, than to a definite function in flight. In very small and young fishes, on the other hand, the wings vibrate to such an extent that they blur, like those of a flying insect. It seems that with an increase in age and size, a buzzing beelike flight is replaced by a true soaring flight, and that the former is very likely a function of absolute size as are so many larval specializations. Flying fishes fly more freely in a strong breeze, and attain greater elevation, speed, and distance than in calm weather. The conclusion is almost inevitable that they utilize the wind to some extent to lift and propel them, even though it is difficult to understand how this would be accomplished.

A detailed description of the flight of one of the larger flying fishes may be quoted from C. L. Hubbs (1918, *Copeia*, No. 62, p. 85–88) as follows:

> The details of the flight of *Cypselurus californicus*, never described with sufficient fullness, may readily be observed by a person at the bow of a small vessel plying through the sea off the coast of southern California, during the summer months. Seemingly indifferent to the direction of the wind, and without apparent unison in their flight, these flying fishes scatter before the boat, as Dr. Jordan says, like grasshoppers before one walking in a meadow.
>
> They appear never to leap directly into the air, as some species are said to do, but, on emerging from the water with greater or less velocity, they immediately spread their wide pectoral "wings" and move forward on the surface like tiny aeroplanes, for a distance averaging perhaps twenty-five feet. While on the water, their sole source of propulsive power appears to be the normal organ of locomotion in fishes—namely, the tail. The pectoral fins, to be sure, are seen to vibrate, but apparently with neither sufficient amplitude nor velocity to propel the fishes forward on the surface, nor to raise them from the water. The vibration of the "wings," though claimed by some to indicate true flight, seems to be due to the less evident, but still observable shaking of the whole body, which in turn is evidently caused by the rapid side-to-side sweeping of the strengthened lower lobe of the caudal fin. The greatest movement of the "wings" is toward their tips, apparently because the fin is rather flexible distally, and because the amplitude of motion is much increased so far out from the body. The moment the fishes rise into the air, their

[1]Dowd, R. E. 1921, The Aeronautics of the Flying Fish. *Aerial Age Weekly*, Jan. 10, pp. 464–465. 3 figs.

THE BUTTERFLY FLYING FISH

Enlarged 1¾ times

Young of a "four-winged" flying fish (*Cypselurus furcatus*). Its mottled color, unlike that of the adult (see next plate) is doubtless correlated with a habit of hiding about drifting weed. It is one of those species the young of which have a double barbel on the chin. From a painting by Helen Tee-Van

A FOUR-WINGED FLYING FISH

Slightly reduced

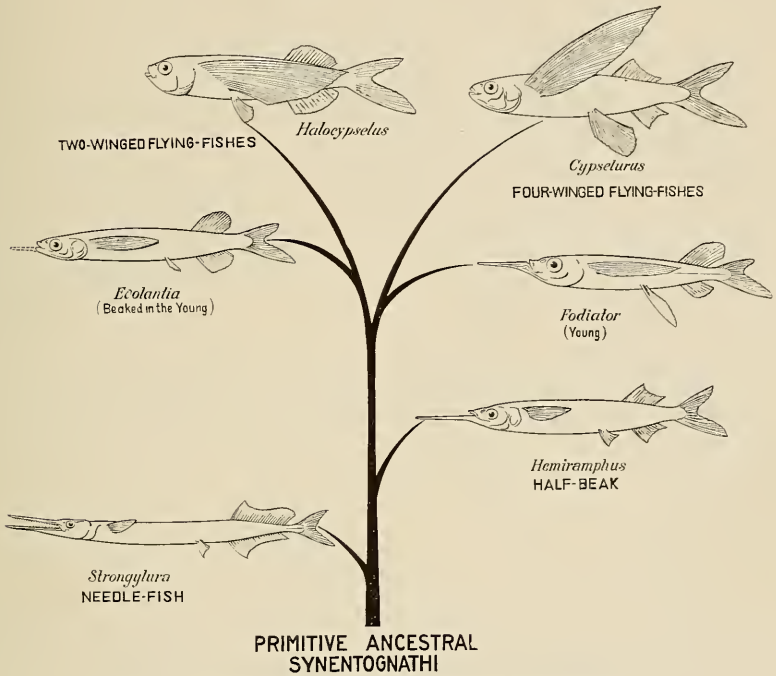
An adult "four-winged" flying fish (*Cypselurus furcatus*), with ventral fins placed posteriorly and enlarged to function as secondary planes. Its color matches that of the "two-winged" species of similar habitat. It measures about six inches "over all" when full grown. From a painting by Helen Tee-Van

A TWO-WINGED FLYING FISH

Slightly reduced

One of the "two-winged" flying fishes (*Halocypselus evolans*). Its beautiful blue color matches that of the open ocean, and is characteristic of animals which float or swim unattached at the surface on "blue water." When full grown this fish attains a length of about six inches. From a painting by Helen Tee-Van

pectorals are held taut: when viewed from the rear they are seen clear-cut, like knife edges. It is very probable, therefore, that not only while on the surface, but in the air The turning is apparently accomplished by the tail and tail fin, which are seen bent in the direction toward which the course is being altered.



Tentative family tree of the needle-fish, flying-fish group

as well, the great pectoral fins (of this species, at least) are not flapping wings, but rather planes of support.

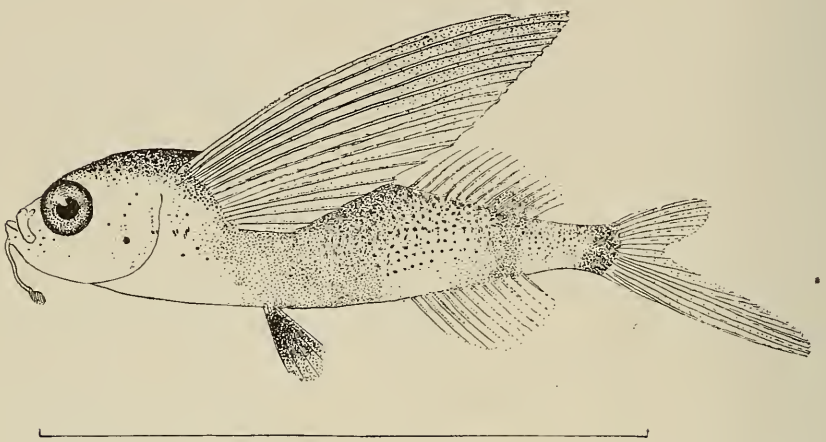
While the flying fishes are attaining on the surface the velocity necessary to carry them soaring away through the air, the ventral fins, also enlarged in *Cypselurus*, remain close-folded against the body. Suddenly they are broadly spread, as elevating planes, and the fish gracefully rises into the air. During the flight the ventrals seem to serve an additional purpose: for, when observed from the advantageous position directly in line with the course of flight, these fins may be seen repeatedly changing their plane, sometimes independently. Apparently serving thus as stabilizing planes, they seem to keep the course of the fishes through the air rather steady, even in a gale. No such regulatory movement of the pectoral fins is apparent.

The flight of these fishes is often straight in direction, but not invariably so; when well under way it may even become semicircular.

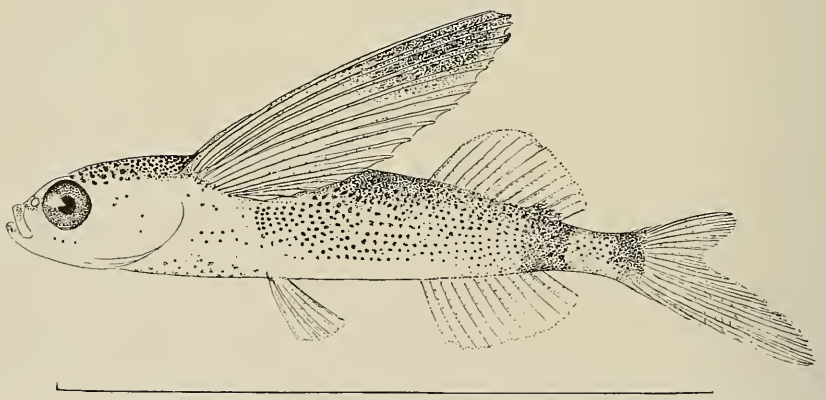
During their flight, the fishes seldom rise higher than about five feet (though they may be farther above the trough of the swells), except when forced upward by a gust of wind. The length of the initial flight, unless following a very poor start, varies usually between fifty and three hundred feet; but when flying with the wind, distances of about a quarter mile in the air are occasionally made.

While in the air, the body appears to be arched upward, and the tail is held lower than the head. As the flight reaches its end, the force of gravity having gradually overcome the upward thrust of air pressure against the pectoral planes, the lower caudal lobe strikes the water first, and the ventral fins are folded. The fishes now either suddenly end their flight, or continue it, they being in the same position as when they first came to the surface. The second flight is a repetition of the first. The necessary velocity to propel them through the air is again attained on the surface by the rapid movement of the tail,

which begins as soon as the caudal fin touches the water. Two or three successive flights are frequently made, and occasionally four, or even five, are undertaken before the fishes soar straight toward the side of a vessel, until they seem about to crush themselves. But they suddenly plunge into the water, twist directly backward in their course within



Young two-winged flying-fish, *Halocypselus obtusirostris*. The barbel will distinguish it from the common *H. evolans*



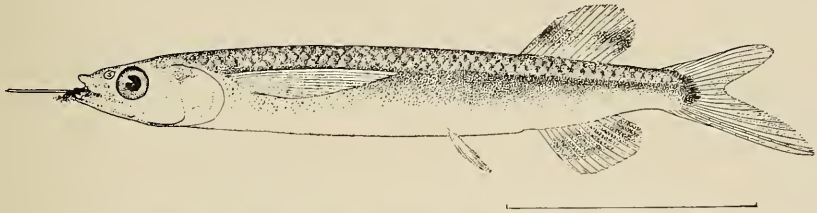
Young two-winged flying-fish *Halocypselus evolans*. To give the scale, a reference line of one inch accompanies this and the other figures

finally sink beneath the surface. Usually the flights are of increasingly shorter distance and duration; at the end of the last the pectoral fins, as well as the ventrals, are instantly folded, and the fishes drop into the water with a splash. They light in a horizontal position, ready for their dashing movements which are seen for a second under the surface.

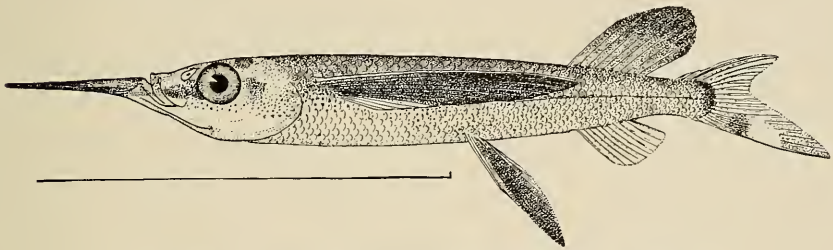
Owing to the greater resistance offered by the water, changes in the direction of movement are much more swiftly accomplished in that medium than in the air. Sometimes they a radius of about ten feet, and make away in the opposite direction, either in the water or in the air.

Now let us consider the relations between different flying fishes, from what manner of fish they have been developed, the trend of evolution in this group. There is little question that they are descended from some billfish-like ancestor, through the half-beaks. The billfish, or marine gar is a

long, slim-bodied fish with excessively elongate jaws armed with sharp teeth to the tips. In billfishes the habit of leaping out of the water is notably developed, more than in most fishes, a halfbeaks, frequently come more or less clear of the water at an angle with its surface and, leaping and skittering along, are virtually dancing on their tails. From this we have the name



The beaked young of *Evolantia microptera*, a primitive flying fish



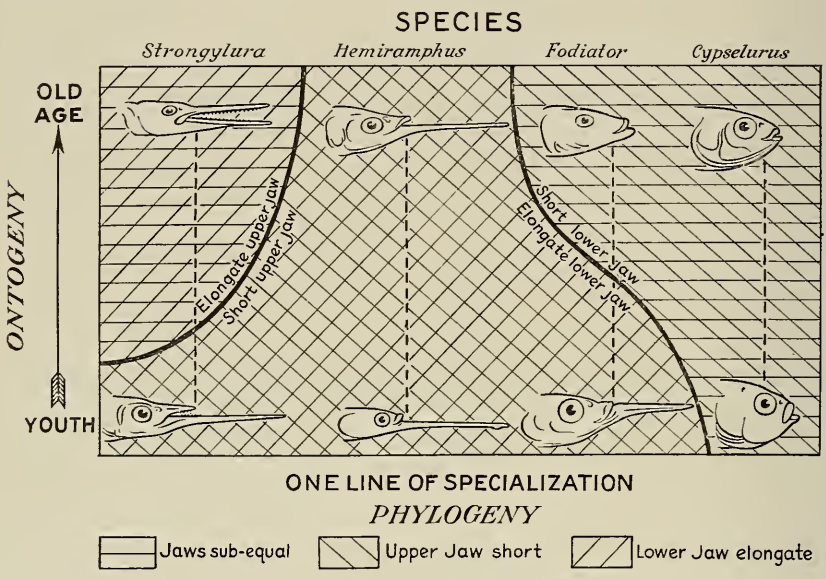
The beaked young of *Fodiator acutus*, a primitive flying fish

vigorous under-water locomotor apparatus being capable of projecting them into and through the air as a dart or javelin might be thrown. In very young billfish the upper jaw is much shorter than the lower, probably associated with some specialized larval feeding habit. All the evidence, which we cannot go into here, points to the halfbeaks as being in a sense "fixed larvæ" of the billfish group. This is another way of saying that the short upper jaw originally developed by small billfish as a larval specialization was later retained by some of these (primitive halfbeaks) to the adult condition. As the billfishes are active leapers, so the flying fish group already had at least the beginning of an aërial habit before the development of specialized wing (fin) structures, correlated with that habit's extension. Some of the billfishes, and particularly of the applied to them throughout the Spanish Main, "ballao," corrupted to "ballyhoo." It is noteworthy that the more flying fish-like and the less billfish-like the series becomes, the greater is the pectoral fin (wing) development, and the prolongation of the lower caudal lobe, the latter obviously a character of service in skittering along the water, or in throwing the fish into the air.

It is noteworthy that the pectoral musculature of the halfbeaks is approximately as great as that of the flying fish, which suggests that this mass of muscle is necessary to hold the pectoral fins rigid as planes. They function as such in the halfbeaks as well as in the flying fishes, but on account of their lesser surface only succeed in raising the head instead of the entire body.

In one of the more primitive flying

fishes, (*Fodiator*), the young have a long lower jaw like that of a halfbeak, which is gradually reduced with age, until the adult has only a pointed chin.



Evolutionary diagram showing greater duration of the half-beak character in young than in adult

In most of the species the jaws have become quite short, undoubtedly much as in some remote ancestors, even antedating the billfishes. Another primitive flying fish (*Evolantia*), with short wings, has a "half-beak" in the young which is of a different character from that of *Fodiator*. With the growth of the fish, this projection does not merely lag; seemingly the normal thing is for the skin of the beak to break away from its slender central supporting cartilage, the cartilage then breaks off, and the skin heals on to the chin. A peculiar specialized character, present in the young of some species of flying fishes and absent in young of others, without any known reason, and a character without any known function, is a single or double barbel, frequently large, or fringed, hanging from the chin. Lacking any other explanation, one may fancy some homology between such barbels and the skin of the beak in *Evolantia*.

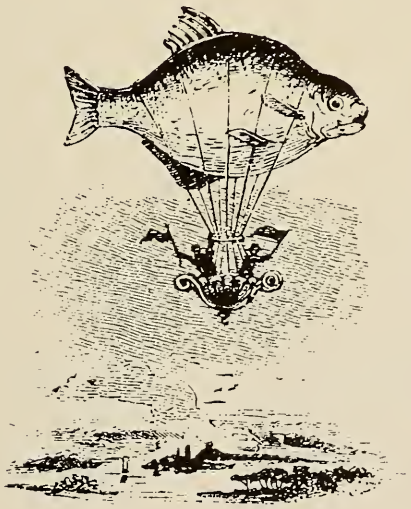
Specialized flying fishes divide themselves into two groups, according as the pectorals only are used as planes in flight, or the ventrals also, placed farther back, are enlarged and function as secondary planes. The first group are sometimes spoken of as two-winged, the latter group as four-winged flying fishes, and the two seem to have been derived respectively from primitive forms resembling *Evolantia* and *Fodiator*.

Our study of the flying fishes of the family *Exocoetidæ* indicates for them a family tree the main features of which are explained in the diagram cn page 73

This group shows certain progressive modifications of its variant characters very prettily. Certain notable changes, which are somewhat involved, we have attempted to show in the appended diagram. A progressive shortening of the

jaws is shown in the top row of heads (*Strongylura* to *Hemiramphus*, and *Fodiator* to *Cypselurus*). This may represent phylogenetic development along one line of specialization in one character. Then along the bottom row of heads we have indicated the young of these same genera, so that reading vertically one finds the ontogenetic development of each form from youth to old age. Thus with ontogeny and phylogeny as ordinates, various curves may be plotted, delimiting the reduction of either jaw both with reference to phylogeny and ontogeny. Reading from the left to the first curve, we have the long upper jaw only in the adult form of *Strongylura*. To the right of this line we have all small upper jaws. Reading to the second curve, we have long lower jaws which reach from the young of *Strongylura* to *Hemiramphus* and to the young of *Fodiator*. To the right of this line we have both jaws short. The cross-hatching emphasizes this overlap. One thing that this method of plotting brings out forcibly is that the *Hemiramphi* amount to fixed larval *Strongyluræ*—whereas the long lower jaw of young *Fodiator* is simply the retention of an ancestral character in young stages.

THE FLYING-FISH.



Tail piece to the chapter on "The Flying Fish" in Yarrell's *History of British Fishes*, Vol. 1. Possibly engraved by Thomas Bewick

On the Association of the Common Goby (*Gobiosoma bosci*) with the Oyster, Including a Case of Parasitism[1]

By THURLOW C. NELSON
Professor of Zoology, Rutgers University

THERE is no group of fishes, the various species of which are more interesting in their many and diverse habits, nor more appealing in their droll appearance, than the gobies. These gobies are mainly tropical, and among them are those famous fishes which hop along the beaches or even climb trees in search of prey. One species, however, the common brackish-water goby, *Gobiosoma bosci*, Lacépède, may be found in numbers on the oyster beds within a few miles of New York City and, though less spectacular than its "terrestrial" and "arboreal" relatives of the tropics, it is not less interesting.[2]

THE COMMON GOBY AND ITS HOME

A little search among the gaping shells of dead oysters on an exposed flat at low tide, or on the deck of an oyster boat as the oysters are being dredged, will generally yield several specimens of this little fish. If one of these is dropped into a dish of brackish water, it will quickly demonstrate some of those traits of behavior for which the gobies are so well known. As it darts clumsily about the dish in search of some shelter from the light, one thinks not so much of a fish swimming as of a rabbit hopping on its forelegs, with the hind legs bound together and trailing out behind it.

Swimming is accomplished by quick, jerky movements of the pectoral fins aided by the tail, but unlike most fishes seen in an aquarium, the goby is incapable of hanging poised in the water or of gliding gracefully about, owing to the absence of an air bladder. It must remain in contact with the bottom save during the brief intervals when it darts from one shell to another.

Viewed from the side, the fish is seen to rest on its confluent pelvic fins (which form a body very similar to a grocer's scoop), and it is also supported by the anal fin as is shown in Fig. 1, or by the whole posterior part of the body as may be seen in Fig. 2. Sometimes one or the other of the pectorals is used as a support when the fish reclines on its side. Rarely are both pectorals in contact with the bottom as is shown in Fig. 3. When the fish does have these outspread, it usually lists slightly to right or left, leaning more on one pectoral than on the other and often with the tail bent sharply toward the same side to give additional lateral support—as is clearly shown in Fig. 4. The fish may remain quietly in this position for long periods, with body and fins motionless, the only movement being the rhythmical rising and falling of the opercula in respiration. Now and then the fish rolls its bulging eyes from side to side in a manner comical to see, and when attracted by some object, the goby may turn the head

[2]The writer is indebted to Mr. J. T. Nichols and to Dr. E. W. Gudger, of the American Museum of Natural History, for identifying the specimen and for valuable references and suggestions.

[1]From the Zoological Laboratory of Rutgers University, Publication No. 8, New Jersey Oyster Investigation Laboratory.

Fig. 1.—The goby with the elevated anterior part of the body resting on the conjoined pelvic fins. The anal fin and the right pectoral fin aid in preserving equilibrium

Fig. 2.—The goby reclining at ease on its right side, the head somewhat elevated, the posterior part of the body resting on the bottom of the aquarium

slightly to one side or the other without moving the body.

The mature male measures approximately 50 millimeters (2 inches) in length. In color a grayish-brown, transversely marked with ten[1] narrow, yellow bands (which in the male become brilliant during the breeding season) with the head and the bases of the pectorals blotched with deep brown, the goby is well colored to render it inconspicuous when on the bottom. Such protection can be of only occasional use to the fish, however, for it spends most of its time concealed between the gaping shells of dead oysters or clams in which the ligament still holds the shells together.

[1]Jordan and Gilbert give "seven to eight paler transverse bars."

FOOD AND FEEDING HABITS

In its secluded hiding-place, the goby finds abundant food in the copepods which pass in with the surrounding water, and in the small polychaete

Fig. 3.—The goby resting on the bottom with the pectoral fins outspread to keep it from turning to one side

Fig. 4.—The goby with outspread pectoral fins and tail turned to one side. This is a favorite attitude with this goby

worms (*Nereis limbata*) which abound in clusters of oysters or shells wherever there exist narrow crevices into which they may crawl. If a small *Nereis* is added to an aquarium, a hungry goby will "hop" rapidly toward it and, seizing the worm in its strong toothed jaws, will shake it vigorously as a terrier might shake a rat. When most of the "squirm" has been shaken out of the worm it is eaten.

A most interesting food relation involving the goby and the living oyster is indicated by observations on one of the English gobies, *Gobius microps*, at the Fisheries Experiment Station, Castle Bank, Conway, England. The heaviest fall of oyster spat occurred in one of the tanks containing a number of gobies which were not present in the other tanks. It is the belief of Doctor Dodgson, director of the Station, and of his associates, that the gobies through reducing the numbers of copepods present left a relatively much larger food supply for the larval oysters in the tank. The food of the larval oyster is not definitely known, but the investigations which have been in progress for several years at Castle Bank, England, and the work of Spärck (1927) in Denmark, indicate that minute organisms such as *Chlorella* probably play a predominant rôle. Since copepods and their larvæ also live on such organisms, it is probable that any reduction in the numbers of copepods present would make available more food for the oyster larvæ.

BREEDING HABITS

In late May and early June in New Jersey, as water temperatures approach 68° F., the gobies associate in pairs in gaping oyster or clam shells and here the eggs are laid. The eggs of the goby are not deposited in a rounded mass such as Dr. E W. Gudger (1927a) has recently described for the gunnel, but each egg, enclosed in an oval, transparent, tough capsule, is cemented fast by one end to the inside of the shell. The capsules are placed as close together as possible, forming a veritable mat of egg cases, each standing on end, Figs. 5, 6. When an area of shell from one to two inches square has been covered by the capsules, the egg-laying stops and the male remains inside the shell to protect the eggs from enemies. As Doctor Petersen (1917) of the Danish Biological Station says: " . . . the males exhibited a most touching care in guarding the eggs so that neither crabs, starfishes, nor other intruders might devour them.'"

Two stages in the development of the young gobies are shown in Figs. 5 and 6. The ovoid capsules, though thin and quite transparent, are very tough, and afford a degree of protection to the little fish within, which is surpassed only by the egg cases of some of the skates. In addition to this tough covering, the young benefit from the watchful care of the male for, as in most fishes which remain with their young, it is the father that is left at home "to care for the children." Perhaps this curtailment of his freedom sours his temper; at any rate he becomes very pugnacious and vigorously resents any attempt to enter between the shells which shield his little brood. After several weeks the young hatch, and as Doctor Petersen and his coworkers have shown, there follows a pelagic or free-swimming period at the surface after which they take up their abode between shells such as those which sheltered them during their embryonic development.

PARASITISM OF AN OYSTER BY THE GOBY

As might be expected where two animals live in as close an association as do the goby and the oyster, an occasional instance of that most intimate association, parasitism. may result. In a fish as large as the goby such parasitism, if it covered the entire life span of the fish, could not but be detrimental to the existence of the species and hence would not be perpetuated. Such instances of parasitism as do occur are to be looked upon as purely accidental, but they hold great interest for the zoölogist as indicating ways in which complete parasitic relationship may be entered upon within the life span of two single individuals. Such instances hold still further interest since cases of true parasitism among vertebrates are, with the exception of certain groups of normally parasitic fishes, very rare, (Gudger, 1927b).

Associations of fishes with bivalve molluscs are well known, but in each instance the fish is at most a harmless commensal, spending usually only its larval life within the gill chamber of the mollusc. Such is the case reported by Welsh in which specimens of the giant scallop taken between Montauk Point and Cape May within the twenty-fathom curve were found to harbor within the gill cavity the young of the squirrel hake, *Urophycis chuss*, ranging in length from 27 to 70 millimeters (1 inch to nearly 3 inches). The whole story of this relationship is not known, but since neither fish nor mollusc apparently undergoes any modification as a result of this association, it is probable that the young hake make use of the protecting shelter of the scallop shells for but a short period early in their development.

A closer relationship between fish and bivalve mollusc is that of the much elongated fish, *Fierasfer*, which lives within the mantle cavity of the pearl oyster, *Meleagrina*, in the warmer American waters. As it uses the oyster merely as a place in which to hide,

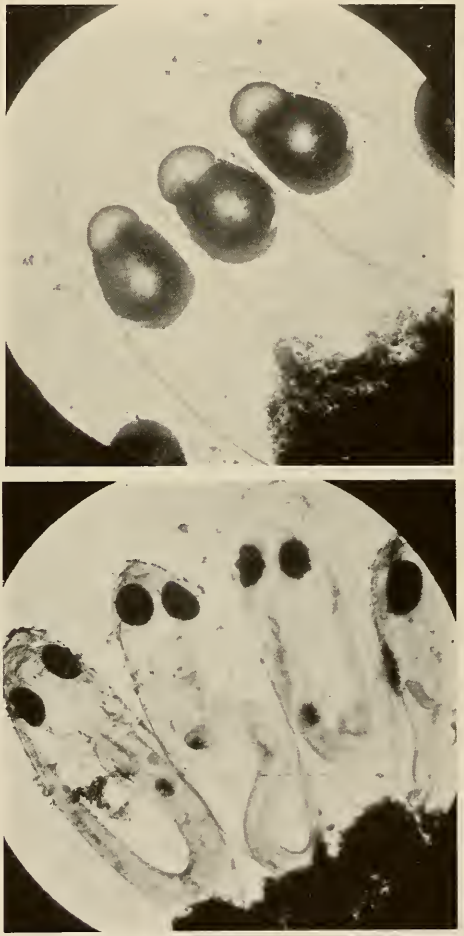
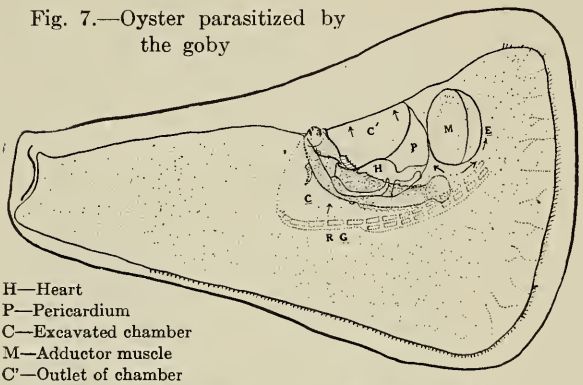


Fig. 5.—(Upper) Photomicrograph of the egg capsules of *Gobiosoma* containing eggs with early embryos lying on the yolk sac. Fig. 6.—(Lower) young gobies within the egg capsule nearly ready to hatch. The yolk sac has been completely absorbed. Note the very black eyes and transparent bodies of these fish which soon are to enter upon a pelagic existence where their transparency will aid them in escaping their enemies

These figures magnified approximately 30 diameters

making frequent excursions into the surrounding water, it is looked upon by some zoölogists as not even a commensal but as a lodger. Occasionally one of these fish forces its way between the mantle and the shell to a point anterior to the adductor muscle. In this position it may become lodged and covered with a layer of mother-of-pearl as shown by specimens in the U. S. National Museum, the American Museum, and the British Museum. (Fig. 8). Another fish of similar habits, probably *Oligocottus*, has also been found entombed in "nacreous splendor" on the surface of the shell of the pearl oyster (Stearns, 1889). The fishes *Batrachus* and *Ophidium* may also occur occasionally in oysters (Dekay, 1842).

Fig. 7.—Oyster parasitized by the goby



H—Heart
P—Pericardium
C—Excavated chamber
M—Adductor muscle
C'—Outlet of chamber
E—Normal excurrent stream RG—Water tubes of right gill

A somewhat more specialized instance of fish-mollusc association which bears certain parasitic aspects is that of the bitterling of Central Europe, which, with the aid of a long ovipositor, introduces its eggs into the mantle cavity of the fresh-water mussel. Protected by the shells of the mussel the eggs develop into young fry, which then leave to complete their growth outside the mussel.

The reverse relationship, mollusc on fish, affords a case of true parasitism. In the well-known life history of the fresh-water mussel, the glochidia or young attach themselves to the fins or gills of fishes, and here we find in some species a high degree of specificity involving even immunity.

The parasitism of the goby on the oyster here reported represents an instance of true parasitism entered into during the life-span of two individuals, accompanied by marked structural modification of parasite and of host finally reaching a state of equilibrium. An oyster 80 millimeters (3 inches) long, dredged by the writer in Maurice River Cove, Delaware Bay, July 30, 1926, was found to contain a goby 21 millimeters (nearly 1 inch) long. The fish was lying, not in the gill chamber as are the common oyster crabs, *Pinnotheres*, which so often turn up in an oyster stew, but actually imbedded in the soft parts of the oyster. (Fig. 7.) The fish, while still very young, probably soon after the close of the pelagic period, had apparently entered between the shells on the dorsal side of a living oyster anterior to the adductor muscle. Here there is an area of relative quiet, undisturbed by either incurrent or excurrent streams of water. and from which the oyster would have great difficulty to expel the invader. Taking up its abode just anterior to the adductor muscle, the fish, apparently through movements of the tail and posterior part of the body, had gradually effected an invagination in the oyster's dorsal body wall to the right of the intestine which passed anteriorly for 12.5 millimeters (½ inch).

The invagination of the oyster's

body continued ventrally into the right suprabranchial chamber into which was discharged the water which passed through the gills. The bottom of this invagination was in direct communication with ten of the water tubes of the right outer gill and with four tubes of the inner right gill. As a result of this modification, a considerable portion of the outgoing stream of water which normally leaves the oyster posterior to the adductor muscle must have passed through this new exit anterior to the muscle, flowing over the goby as it lay in this invagination. The pectoral fins which in the normal goby are broadly rounded (Fig. 3), showed in this specimen a distinct development of the upper fin rays, apparently to aid the fish in holding its position in the invagination.

Not only had the fish formed a new channel for at least a part of the outgoing water from the gills, but the heart of the oyster which normally lies in a dorso-ventral position anterior to the adductor muscle, was displaced so as to lie almost in an antero-posterior direction. In spite of these two marked anatomical changes there was no evidence at the time of capture that the oyster was suffering any distinct ill effects from the presence of its unbidden guest. This, together with the high degree of structural modification, indicates that the relationship was one of rather long standing, perhaps two or three years, during which equilibrium had become established.

The goby. though but 21 millimeters long, was swollen with eggs, showing it to be a dwarfed specimen

Fig. 8.—A small fish (presumed to be a *Fierasfer*) embedded in and covered over with the nacreous layer of the inside of a pearl oyster (*Meleagrina*). Photograph of a specimen in the American Museum

much older than its size indicates. Hand in hand with the dwarfing went that companion change almost invariable in parasitism, hypertrophy of the sexual organs. In the absence of a male no spawning had occurred, as is evidenced by the fact that this specimen was full of eggs almost two months after the close of the normal breeding period of the goby.

The source of the food of this goby can only be conjectured. The outgoing stream of water passing over the fish had already gone through the oyster's gills where every organism larger than a small bacterium would have been removed. The surrounding water, therefore, could have brought the goby nothing of use to it save oxygen. Its food, then, must have consisted of small worms, copepods, and other animals which, like itself during its first wanderings, passed into the quiet area along the dorsal side of the oyster seeking protection.

In this unique relationship between the oyster and the goby we get a glimpse of the wonderful powers of adaptation of animals to changed conditions. Just when the relationship of goby to oyster was entered into, we have no means of knowing but, from the unusual degree of modification resulting therefrom, it probably occurred when the goby was but a few weeks old and at a time when the oyster was not more than two or three years old.

Similar instances of association in varying degrees must have occurred many times in the oyster beds of the world, but serving no purpose to either oyster or fish, they were not perpetuated. They represent striking cases of failure drawn from nature's vast laboratory; unsuccessful experiments among the great mass of animal associations from which have sprung the very complex cases of symbiosis and of parasitism now known to us.

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Flying gurnard, showing wings made from expanded pectoral fins. The little "hands" represent the separate forepart the pectoral fin. Note the streamline form of the body and the helmet of bony skin

The Versatile Gurnard

SOME OBSERVATIONS ON THE REMARKABLE ACTIVITIES OF THE FLYING GURNARD, *CEPHALACANTHUS VOLITANS*

By WILLIAM BEEBE
Director, Department of Tropical Research, New York Zoological Society

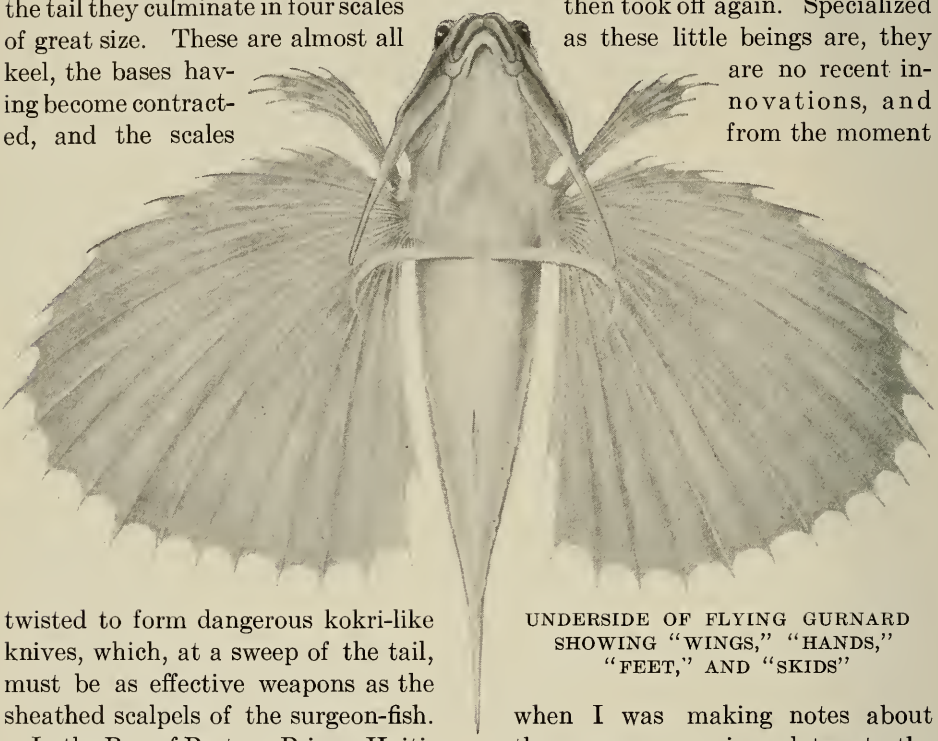
A flying gurnard, from the point of view of limb function, finds its nearest allies among bats and angels, its fins functioning distinctly as hands, feet, and wings. As regards the scope of its life activities it is almost in a class by itself, for while angels and bats have conquered only two elements, a flying gurnard is at home not only in water and air but is able to trot easily about on solid earth. In fact the latter seems to be its favorite mode of progression.

I have seen gurnards rise and scale away from the path of a vessel, and I have had a school of half-grown ones slap against the side of a rowboat. In the young fish the fins are too short for flight but even a two-incher will leap out and spread his diminutive batlike wings, only to flop back at once. At best they are less skillful *aviateurs* than the true flying fish. This is reflected in many body characters such as the wing support, the tips of the pectoral rays being simple and not multiple-branched. The head of the gurnard is encased in solid, heavy armor. To offset this excess of weight anteriorly there is a monoplane arrangement placed far forward, the expanse of actual flight membrane being considerably greater than in the more familiar synentognathous flying fishes. Gurnards may be said to have great muzzle velocity but comparatively little trajectory or range. One of these fishes has been known to knock a sailor senseless by a head-on blow between the eyes, as the man stood at the wheel of a schooner.

A secondary use for the great wing expanse is as a float. Several times, in widely separated oceanic areas, I have seen gurnards, either singly or in a school, sunning themselves at the very surface, with the wings widely spread, floating buoyantly with only occasional flicks of the caudal fin.

I see no reason why a gurnard should fear any enemy or need the power of flight for anything except pursuit of

food or pleasure, for it is one of the thorniest, least edible objects of the sea. To the rear of the cephalic armor and spines, the body is covered with ivory-hard, razor-ridged, thorny scales, which increase posteriorly until at the base of the tail they culminate in four scales of great size. These are almost all keel, the bases having become contracted, and the scales twisted to form dangerous kokri-like knives, which, at a sweep of the tail, must be as effective weapons as the sheathed scalpels of the surgeon-fish.



UNDERSIDE OF FLYING GURNARD SHOWING "WINGS," "HANDS," "FEET," AND "SKIDS"

In the Bay of Port-au-Prince, Haiti, on the recent tenth expedition of the New York Zoological Society, I found young gurnards coming occasionally to the submerged light at night, swimming slowly along with half-spread pectorals. They allowed themselves to be caught with ease. One evening, while visiting Mr. H. H. Rogers' yacht not far from our anchorage, I won eternal fame as a fish charmer by leaning over the gangway platform and allowing a small gurnard to swim straight into my hand—my astonishment being quite as great as that of the captured fish.

When wearing a diving helmet and sitting quietly on the bottom of a coral reef three or four fathoms down, I have seen small gurnards, individuals measuring from two to four inches in length. These swam slowly, and frequently alighted gently on a sprig of coral or on a sponge, examined it carefully, and then took off again. Specialized as these little beings are, they are no recent innovations, and from the moment when I was making notes about them upon my zinc plate at the bottom of the sea, back to the time when the earliest flying gurnard flew over and walked in Eocene seas,—all this is a matter of not less than fifty million years.

In large aquariums on my Haitian schooner, I watched these fish at leisure and was astonished at their peripatetic facility. Every movement brought to mind a strange, half-living aëroplane. A gurnard volplanes swiftly downward from the surface, wings tightly folded, and when close to the bottom turns slightly upward, partly spreads its pectorals and, stretching out the long, thin ventral fins, alights gently, and at once trots off,

scampering here and there, now and then actually holding up one leg fin, as the fish pivots slightly and looks about. When it walks forward rapidly the body is kept almost horizontal, with the tail clear, but when it slows down and begins taxiing across the floor of the aquarium, the caudal fin drops and the lower rays drag, like the tail stick of an aëroplane.

The leglike ventral fins work alternately, one after the other, and each step is effective, sometimes directly ahead, or again to one side or backward. These fins are remarkably long, the fish standing very high; when in action they are constricted, appearing slender and perfectly straight, only the very tips of the rays bending back and functioning as feet. Every now and then the anterior free portions of the pectorals stretch out and down, fumbling about as though searching for something.

In front of the first dorsal fin are two free rays, long, slender, and knobby at the tips, and for their entire length quite separate from the rest. When the fish begins walking, these separate laterally and act as balancers, one on each side, forming an angle of about forty-five degrees. If the gurnard turns quickly or trips up, one of the two rays quickly dips down on the corrective side, exactly as a person's outstretched arms assist in regaining lost balance. The motion pictures which we were able to secure of the walking gurnard show all of these unpiscine refinements.

As I dived day after day, and walked about the coral reefs of Haiti, I was ever more deeply impressed with the astonishing uses to which the fins of fish are put. I saw a dozen or more species which actually, and not as a mere figure of speech, deserve the term walking, while in as many more I watched the pectoral fins being used to turn over bits of coral or to fan loose strands of seaweed away from some edible morsel. Even in this first season's brief study of reef life I saw the occupation and sturdy defense of definite homes, I noted curious sleeping postures and quarters, and extremes of emotion which were reflected not only in the bodily actions and in the motives of the fish, but in the instantaneous shift of individual pattern and color beyond anything which I had ever considered possible. All this serves to bring closer together the lives of these lowly vertebrates and those of our more familiar terrestrial two- and four-footed fellow creatures, who share with us today this little whirling ball of earth and water.

Young flying gurnard, showing "legs" made from the ventral fins

In Southern Waters After Bonefish

ANGLING AMONG THE FLORIDA KEYS AND THE BAHAMAS FOR THE GAMY *ALBULA VULPES*

By VAN CAMPEN HEILNER
Field Representative in Ichthyology, American Museum

OF all the game fishes which it has been my fortune to pursue with rod and reel, none has given me greater sport or greater thrills and enjoyment in the catching than the bonefish (*Albula vulpes*). To my mind he is the gamiest fish of any size or species in either fresh or salt water that an angler can hope to take.

My early experiences with bonefish occurred among the Florida Keys, that chain of coral and mangrove islands which stretches southward and westerly from southern Florida. Here the great mud or marl flats are favorite feeding grounds for these finny warriors and many a winter's day I have spent poling about the banks in a skiff in search of them.

In the writer's opinion, nothing in fresh or salt water can compare with the bonefish for gameness

As Florida became more developed and the real estate boom swept down upon the land, I shifted my cruising grounds to the Bahamas, where banks surrounding more than three thousand rocks and cays provide unlimited possibilities for bonefish. At this point I might remark on the spelling of cay which is pronounced there the same as key and means a small island, such as occurs in the Floridian Archipelago or among the Bahamas. The word is evidently derived from the Spanish *cayo* meaning island and in Florida became contracted to "key." Thus the place Key West does not refer to the westerly island of that group, as is naturally supposed, but to the Spanish words *Cayo Hueso*, meaning "Bone Island" the original name of the place.

I have seen thousands of bonefish, and I have caught or been present at the catching of more than three hundred by actual count. While this experience qualifies me to some degree as an observer of their habits, I am just beginning to learn something about them. And I doubt if I shall ever learn enough to qualify as "expert" and certainly never shall I learn as much about them as I should like to.

An acquaintance of mine after catching his first fifteen bonefish, proceeded one evening around the camp dinner

table to give a dissertation on the subject and to point out wherein I was using the wrong tactics. To my reply that the next fifteen bonefish might not bite nor act in the same manner, his derisive laughter forced me to silence. But it so happened that the very next day, with bonefish all around him, and standing ankle deep in the water but twenty feet from me, he was unable to hook a single fish, while I landed five. The explanation was that the fish that day were biting in an entirely different way from those he had caught, but in a way with which I had had some experience. Be prepared for anything in bonefishing, for you never can tell.

Bonefish as a rule (note I say "as a rule," for no set rules can apply to them) begin to feed on the young flood tide. They have been spending the last of the ebb off in deep water, "settled" in holes or in the channels. At the first feel of the incoming tide they start in over the flats in search of food—crabs and various other small crustacea. The angler, anticipating their movements, has poled and dragged his skiff as far into shallow water as possible, and awaits their coming. He should have a goodly supply of bait and quantities of "chum" (ground up bits of fish or conch) with which to hold them in the vicinity. As soon as he observes a school approaching, he should begin to "chum," throwing the ground-up bait astern and in the direction of the on-coming school, but not close enough to frighten them. A bonefish is one of the most wary creatures that swim the seas. The slightest noise, such as a knocking against the side of the boat, or the least movement will scare him to the vanishing point. I have seen the mere shadow of a bird passing over the surface of the water send a school of bonefish in all directions like a flock of frightened quail.

Harry was fast to a large fish

You cast your baited hook amongst the chum and wait. On come the bonefish, passing back and forth across the clear white bottom, picking up the chum with little whirls of sand. One appears to be right over your bait and your heart beats a triple tattoo. A long, green shadow he seems. Now the long upper lobe of his caudal fin flicks the surface. He is burrowing down for your bait. An almost imperceptible tug comes on your line—the slyest of sly pulls. Quick as lightning you flip back your wrist and set the hook. Then the indescribable occurs.

The line leaps from your reel like a living thing, your rod flies forward and describes a semicircle, and you are suddenly aware that you are fast to a quarry with the speed of light—the sportiest thing with fins. Three, four, five, six hundred feet of line streak from your reel and melt into the sea. Your thumb, gloved in its thumb stall, is pressing down with all its might on the ever diminishing spool. The line, dry near the bottom, sets up such a friction that it blisters your thumb even through the woollen cover. You are forced to dip water over your reel. Suddenly his rush ceases and the fish begins threshing about on the surface six or seven hundred feet away. The water there is full of mangrove shoots and you alternately curse and pray for fear he will get tangled up amongst them. Then, as quick as he ran from you, he starts toward you. You reel like a demon. You reel until your wrist aches, but you cannot get a tight line. The bonefish is abreast of your boat, past it, and going in the other direction, and still your slack line sags behind you in a great belly.

"What sport! What a fish!" The exclamation bursts spontaneously from your lips.

"Where is he? Where am I?"

You are bewildered. You get the impression that if you catch this bonefish after all it will only be because he willed it and allowed you to do so.

But stay! His second and third rushes are not quite as far as the first one. He is now in the process of circling your boat; round and round, the line hissing through the water. He can't get very far away, and yet you can't seem to get him much closer. But he is weakening; you can feel it. His circles are narrowing. You can see him clearly now, the hook protruding from the corner of his mouth, his large glassy eye staring malignantly up at you, his tail weaving determinedly back and forth. But you are weakening too. You've lost your hat in the struggle and the hot tropical sun beats down unmercifully on your head; you've blistered your thumb trying to stop him, and wrenched

Our dusky guide chewing up conch to be used as chum

your wrist in your effort to get in line when he ran at you. Who's going to give up first? Then a voice sounds in your ear.

"Try and bring him a little closer the next time around, Boss, and I'll slip the net under him."

It's your native guide, and his voice acts on your senses like an ice pack on a fevered brow. You make the supreme effort, lift the tip of your rod and strain backward, and head first into the net goes your bonefish.

You lift him aboard, extract the hook, and hold him up. Seven pounds of glistening silver! Is it possible that this small fish which resembles a brook sucker has given you all this struggle? You think of the long, lazy days on the Pacific when you've wrestled with swordfish, of colorful deep-blue days on the Gulf Stream when a leaping, twisting demon of a sailfish was trying to describe geometric patterns with your line. But *they* were *big* fish and this one weighs but seven pounds! You're spoiled for all other kinds of fishing. You've joined the ranks of bonefish devotees.

In recalling some of my experiences with these glorious fighters, one or two stand out in my memory above all others. I remember a day of wonderful sunshine without a cloud in the sky. Not a breath of wind ruffled the surface of the water and the flats at low tide lay staring white under the tropical sun. My companion and I had poled our skiff as close inshore as we could before it grounded, but so low was the tide that we were still half a mile from the beach. We anchored the skiff and putting some bait in our pockets, got overboard and waded ashore. Through the flats, which were mainly dry, ran some little sloughs or pockets and in

The bonefish occurs in warm seas practically all over the world

some of these we could see bonefish "settled."

The tide started in and suddenly there were bonefish everywhere. In any direction we looked, we could see tails and dorsal fins working in across the banks with the rising water. Bonefish to right of us, bonefish to left of us, behind us, and ahead of us. We counted fourteen schools of incoming bonefish at one time. So still did we stand that they often passed almost at our feet. I became so thrilled and interested in watching them that I forgot to cast. But a shout from my companion apprised me that he was fast to one and I soon followed suit.

How many bonefish we hooked on that tide I can never tell. We caught eleven ranging from four to eight pounds. Once my friend had all his line out and had to run through the water in order to get some of it back. We stayed until the water crept nearly to our waists and quit, not because of it, but because we were figuratively and literally "fished out."

I remember another balmy day in

late February. With two companions and a guide we were drifting over the flats in the latter's sailboat looking for bonefish. The tide had dropped on the banks and we decided to move off to the edge of the channel and fish in deep water. This we accordingly did, and as not much seemed to be biting, I curled up in the furled sail and went to sleep. I was awakened by confused shouts and exclamations from my companions and drowsily rolled over to see what was up.

"Harry has a big bonefish on," they informed me. "Get your line out quick!"

The fish had run out a tremendous amount of line and was now traveling at right angles to the stern. Suddenly a cry of dismay came from Harry. Directly in the line of march of the bonefish, a stake protruded from the water. If the fish fouled that stake, he was sure to break off. And then our dusky guide evinced some of the little intelligence he had ever displayed. Leaping into a small canoe we had tied astern, he paddled as if the fiends were behind him, reached the stake about ten feet ahead of the bonefish, and pulled it up. The day was saved and though Harry was forced later to pass his rod three times around the mast, he landed the fish, which was a magnificent nine-pounder.

I then cast out and almost immediately had a tremendous strike. The line ran out with such speed that my thumb stall quickly burned through to the flesh. I submerged the reel and rod beneath the water in an effort to allay the friction, but I could not stop the fish. Before we could pull up the anchor or untie the canoe to follow him, the fish ran out nearly a thousand feet of line and broke it at the spool! I shall never know how large that fish was but I like to think of him as the world's record. *The* world's record bonefish hangs in the Game Fish Collection of the American Museum of Natural History. It was caught by Burton F. Peek and weighed 13¾ pounds. But there are larger ones than that to be had, and you, dear reader, might be the one to catch him. Who knows?

The bonefish occurs in warm seas probably all over the world. Dr. Robert Cushman Murphy and the writer found them in Ecuador where the natives seemed not to know much about them.

To get the maximum sport from this incomparable game fish, you should use your lightest tackle. The 3–6 class of the Catalina Tuna Club is just right: 6 oz. tip, 6 ft. rod, and 6 thread line; a reel holding two to three hundred yards of line and strong hooks about 7/0 size, and you are equipped. Once you have caught a bonefish, you will never be the same again.

The Zane Grey Game Fish Collection

By FRANCESCA LA MONTE
Assistant in Ichthyology, American Museum

"Lord grant to me to catch a fish
So big that even I
In talking of him to my friends
May never need to lie."

"TO own a beautiful white ship with sails like wings, and to sail into lonely tropic seas"—this was one of Zane Grey's earliest boyhood dreams. How it came true he has told us in his fascinating books of fishing adventures. These are no "fisherman's tales," for in the north end of the Hall of Fishes of the American Museum the visitor may look over many tokens of Mr. Grey's prowess, from the 758 pounds of blue-fin tuna to the huge mass of ocean sunfish, and see for himself the tangible evidence of what the "lonely seas" yielded to this enthusiastic angler. One's first thought is something very like the admiring comment of George Takahashi, a fishing companion of Mr. Grey, as he beheld one of the big catches, "My goodnish graceness! Awful good luck!"

This collection of big game fishes came to the Museum in 1926 as a gift from Mr. Grey, chiefly through the persuasive powers of his friend and our field representative, Van Campen Heilner. Mr. Grey has promised to add to it from time to time some of the trophies of his cruises. As it stands, however, it includes some of the largest, most beautiful, and gamest of fishes. All of them were caught in a sportsman-like way, with "tackle strong enough to subdue the fish, and not to break off a number of hooked fish in an endeavor to catch one on a lighter tackle."

Above the entrance to the proposed Roosevelt Memorial Hall hangs a Pacific sailfish, the prize of a contest in strength and endurance, won only when this lithe, silvery body with its deep-blue sail was hauled lashing and dripping over the side. One can well imagine that other labels, verbal and less scientific than the present one, "Ocean Sunfish, *Mola mola*," were applied during the process of catching the 2000 pounds of slippery flabbiness now flattening its bulk against the background of the case beneath the sailfish. But trophies like these are worth hot suns, aching muscles, and the bitter disappointment caused by the fisherman's will-o'-the-wisp, that "largest one of all"—that always escapes.

Of course there are some amberjacks, a tarpon, the fierce pike-like barracuda, a wahoo, and a kingfish. But there are very few things to be taken for granted in this collection, certainly not the seemingly innocent bonefish, standing on its head in a feeding position in one corner of a case,—in reality one of the hardest fighting fishes that swims. Nor does every sportsman's list boast a 582-pound broadbill sword-fish, the world record until replaced in 1927 by a 588½-pound catch of Mr. Grey's brother, R. C. Grey.

The glistening silver and blue bodies of two of the most beautiful fish in the collection stand out against the dark, greenish-black of their case neighbor, the black marlin. These are the spectacular rooster fish or pappagallo,

NORTHWEST WALL CASE OF THE ZANE GREY GAME FISH COLLECTION

Above this case hangs the 758-pound world record tuna caught by Mr. Grey off Port Mackay, New

NORTHEAST WALL CASE OF THE ZANE GREY GAME FISH COLLECTION

Particularly noticeable in this case are the bonefish, *Albula vulpes*, and the barracuda, *Sphyræna barracuda*

whose dorsal fin rivals the tail of the proudest rooster, and the yellow fin albacore, *Thunnus macropterus*. Mr. Grey describes the capture of this albacore in one of his books. In its surface run at one time, this fish had 400 yards of line out, and before the end of the fight it dove, taking off half the line with the drag on. When the drag was released, the fish went on down and Mr. Grey had to lift it from a depth of 1300 feet. After it was dragged up to the surface, it took three men to haul it into the launch.

Ocean sunfish (*Mola mola*) caught by Mr. Grey. Weight 2000 pounds

But even more exciting is Zane Grey's vivid account of the capture of the record tuna, which he describes in his recent book, *Tales of Swordfish and Tuna*. Inspired by the example of Captain Laurie Mitchell of Liverpool, Nova Scotia, who held the world record at that time, Zane Grey went

to Nova Scotia to fish for tuna, well equipped with what he calls "a mixture of Florida and California methods." His apparatus consisted of two light skiffs, two-oared, sharp fore and aft, and round as a spoon on the bottom; and a launch 25 feet long, 7½ feet beam, light and strong, with two engines and guaranteed to make eighteen miles an hour and turn round in its own length at full speed. All three boats were furnished with special Catalina revolving chairs with rod sockets. His tackle included Coxe reels, Murphy hickory rods, and Ashaway linen lines. For chum and bait the fishing party used native herring.

The capture of this huge tuna did not take place until Mr. Grey and his friends had been in Nova Scotia for some days, and in spite of disappointments and foggy weather, had made several other big catches of tuna. However, on a certain day when, in answer to the signal of a Nova Scotian fisherman, they threw out bait, Mr. Grey felt that something extraordinary was at the end of the line. Unlike the previous rather temperamental tunas, this fish swam deep, evenly, and somewhat heavily. To the dismay of the anglers, it first ran in among the commercial fishermen's nets, but at last swerved and turned toward open water. Its approach to the reefs of Blue Island, at the risk of cutting the line on the jagged rocks; its turnings; its attempts to head inshore, and Mr. Grey's successful efforts to turn it around toward open water: these form one of the most thrilling stories ever told by an angler. Finally, after the boat had alternately pursued the fish and been towed by it, and Mr. Grey's strength was nearly exhausted by the tremendous muscular effort and skill necessary to keep the tackle from giving under the strain, he succeeded in pulling the fish to the surface and then near enough to lasso and tie it to the stern. The fight had lasted three hours and ten minutes and it took nearly two hours to tow the catch back up the bay to the breakwater. Mr. Grey writes that when the fish was finally hoisted out of the water he could not believe his own eyes. It was even larger than he had anticipated. The native fishermen were amazed to find that the thirty-nine thread line had held and subdued this huge creature 8 feet 8 inches long, 6 feet 4 inches in girth, and weighing 758 pounds.

Perhaps we at the Museum got a faint echo of the breath-taking thrill of these adventures when this great collection arrived and one by one the big packing cases were opened revealing foot after foot of fish, each specimen more startling than the last. And if at times five men struggled to fasten one of the larger fishes to the wall in the Hall of Fishes, what can have been the struggles to capture its resisting, and doubly or triply heavy living body!

The scenes of some of Mr. Grey's cruises, and magnificent views of fish leaping above the surface and fighting on the hook are shown in Mr. Grey's most recent gift to the collection, a series of large colored photographs which will hang on the wall opposite the cases.

Surely many sportsmen and many who are not sportsmen will look at this collection with interest and envy, and recalling that combination of strength, intelligence, fair play, and fun that makes big game fishing a real sport, will heartily agree with Mr. Grey himself that "to catch a fish is not all of fishing."

Carl H. Eigenmann—Ichthyologist[1] 1863-1927

By GEORGE S. MYERS
Leland Stanford University

IN 1877 a thirteen-year old German lad first set foot on the shores of the United States. He grew up in the care of an uncle in Rockport, Indiana. In September, 1882, the boy was admitted to the state university at Bloomington, and entered upon a career which was to take him to a commanding place in American science.

From a recent photograph (1924) of the most distinguished student of the blind cave vertebrates of North America, and the fishes of northern South America

At Indiana University David Starr Jordan occupied the chair of zoölogy, and three years later the presidential position. Those were the days of rigid requirements in the "classics," and young Carl Eigenmann began the study of Latin. But Latin was not to be his work in life, and when Doctor Jordan overturned the old system, Eigenmann chose zoölogy. Under Jordan's guidance he began the study of North American fishes. In 1885 his first paper, a review of the Diodontidæ of North America, appeared. He became an instructor in the department and received his bachelor's degree in zoölogy in 1886.

In the fall of 1886 an opportunity for the principalship of a school in Santa Paula, California, came to Eigenmann through his classmate, Barton Warren Evermann. Eigenmann arrived too late for the position but remained for a while in the state. Going south to San Diego, he there met Miss Rosa Smith, already becoming known by her papers on west coast fishes. Following a short romance, the two were married at San Diego on August 20, 1887. They immediately went north by boat to SanFrancisco, and thence across the continent to Harvard University. There arrangements had been made for the two ichthyologists to study the immense fish collections made by Louis Agassiz in Brazil many years before, and up to that time practically unworked.

Excepting for a short stay at Wood's Hole in the summer of 1888, the Eigenmanns were at Harvard until December of that year. Jointly they completed, besides several shorter papers, a review of the catfishes of South

[1]Born at Flehingen, Germany, March 9, 1863; died April 24, 1927, at Chula Vista, California.

America, a tremendous undertaking, the final report on which was published by the California Academy of Sciences in 1890.

Returning to California, Eigenmann, who had meanwhile received his master's (1887) and doctor's (1889) degrees from Indiana, was for a time curator of the San Diego Natural History Society, and while there established the San Diego Biological Station. From 1889 to 1891 he was acting curator of fishes in the California Academy of Sciences.

Doctor Jordan and a large part of the Indiana faculty having been called to California for the establishment of Stanford University in 1891, Eigenmann returned to his Alma Mater as professor of zoölogy. Opportunity for ichthyological work was not long in appearing, and in 1892 we find him in the Canadian Northwest, collecting fishes for Albert Günther, keeper of zoölogy in the British Museum, the collections being reported on by the Eigenmanns before shipment to London. After this Eigenmann turned his attention toward studies of variation and of the origin and differentiation of the sex cells in certain of his Pacific Coast fish material. This latter work contributed greatly to his reputation.

Study of the Agassiz collections had whetted an appetite that could not be appeased, however, and though during the nineties little South American material fell into his hands, Eigenmann was merely awaiting an opportunity. It was during this interim that he turned toward the field in which it may be said he placed his name among those of the foremost American men of science.

Possibly the most striking members of the fauna of the limestone country of Southern Indiana and Kentucky are the blind creatures of the underground rivers which traverse the innumerable caves of the region, and of these the blind fishes of the family Amblyopsidæ are most prominent. To the study of these and of the other cave vertebrates Eigenmann turned his attention, and for a period of twelve years a veritable stream of papers by himself and his students issued from the laboratory in Bloomington. The culmination was the publication, in 1909, by the Carnegie Institution of Washington, of *The Cave Vertebrates of America, a Study of Degenerative Evolution*, a magnificent volume and the best known of Eigenmann's works. During the course of these studies Eigenmann visited most of the important caves of Indiana, Kentucky, Arkansas, and Texas, finally making a trip to the caves in Cuba. Plans made for an exploration of the caves at Merida, Yucatan, were never carried out, and the blind fishes there, if they actually exist, have never been made known.

But even in the height of his studies on the blind forms, Eigenmann did not forget the glittering array that inhabited the streams of the southern continent. After 1900, several South American collections fell into Eigenmann's hands, the most important being the extensive materials obtained by Dr. J. D. Anisits in Paraguay. On these, on collections sent by Von Ihering from southern Brazil, and on the South American fishes in the National Museum at Washington, Eigenmann published several papers.

Accidental contact with Dr. W. J. Holland, director of the then recently organized Carnegie Museum at Pittsburgh, started new plans, which later developed into a curatorship of fishes

at the museum, lasting from 1909 until 1918. An opportunity was provided in 1907 for one of Eigenmann's students, John D. Haseman, to travel in South America primarily for ichthyological material. During the three years that Haseman was in the field, he covered more territory than has any single ichthyological expedition before or since, and from the Amazon and most of the large rivers between it and the Paraná, he brought a very nearly unrivalled collection.

Meanwhile, as an accompaniment to the report on the meager materials of the Princeton Patagonia Expeditions, Eigenmann had published an elaborate outline of his theory regarding South American zoögeography. He supported in the main the theory of Von Ihering, viz., the existence at one time of a land mass connecting Africa with parts of the Neotropics, basing his conclusions on the similarity of the African and American ichthyfaunæ.

Soon after finishing his long delayed preliminary report on the characins of the Harvard Museum, Eigenmann himself took the field. On his own funds, backed by promise of somewhat indefinite support by the Carnegie Museum, he went to British Guiana in 1908 on what was to be his most fruitful journey. His principal object was to explore the streams of the Guiana plateau, where he hoped to find the relics of the old Gondwana fauna, and, further, he wanted material for his characin monograph. During a few months in the winter of 1908–1909, Eigenmann made an enormous collection, containing literally hundreds of unknown forms, and making British Guiana for all time one of the classic collecting grounds of Neotropical ichthyology. He did not find the relic forms he had expected on the plateau, but the wealth of material more than made up for the loss. On his return, the Carnegie Museum assumed the expense of the collection and of the publication of the results. The outcome was a magnificent report, *The Fresh-water Fishes of British Guiana*, published in one ponderous volume in 1912, the most important single work in South American ichthyology.

Before the Guiana volume was printed we find Eigenmann again in South America, this time on the Magdalena and Atrato rivers, and the plateau of Bogotá in Colombia, from January to April, 1912. Returning, he almost immediately sent two of his students, Arthur W. Henn and Charles E. Wilson, to western Colombia, later providing for further explorations by Henn in Ecuador. The results of these expeditions were embodied in a report entitled *The Fresh-water Fishes of Northwestern South America*, quite as bulky as the Guiana volume but finally issued in much reduced form by the Carnegie Museum in 1922.

In 1918 Eigenmann again went to South America, this time to the high Andes of Peru and along the coast through Chile. The principal result of this trip, *The Fresh-water Fishes of Chile*, is about to be issued by the National Academy of Sciences. It was on this trip that the strain of the great altitudes broke the indomitable strength of Eigenmann, once before weakened by fever in Colombia, and it is from this time on that we must mark his decline in health.

In 1920 Eigenmann initiated a survey of the fishes of the eastern slopes of the Andes by sending William Ray Allen to the Marañon, Huallaga, and other upper reaches of the Amazon. The material collected by them, although partially identified, remains to

date unreported on. In 1921 the work was carried on by another student, Nathan E. Pearson, in the Beni Basin, and again in 1922 by Pearson in the Andes of Southern Peru and Bolivia. The Beni fishes were worked up by Doctor Pearson and his Andean report is completed. Finally, too late, Eigenmann turned his attention to the lowlands of the mighty Amazon. From 1923 to 1925, Dr. Carl Ternetz, who many years before had collected along the Paraguay for Doctor Anisits and for the British Museum, traveled down the Rio Tocantins, along the Amazon to Manáos, up the Rio Negro and through the Cassiquiare to the Orinoco, and down that stream to Caicará. The collections he made, richer than any brought from South America since those of the Agassiz Expedition and possibly even surpassing them, lie almost untouched in Bloomington.

Throughout this period of extensive South American work, Eigenmann was gradually putting together his great monograph of *The American Characidæ*, by far the largest and most diversified family of the immense Neotropical fish fauna. The first three parts appeared between 1917 and 1921, published by the Museum of Comparative Zoölogy at Harvard. Part four has recently been published, and part five, the last finished by Eigenmann, is in press. Yet but a third of the group is covered. Besides this Eigenmann completed monographs of the Cheirodontinæ, a characin subfamily (1915), the pygidiid catfishes (1918), and the doradid catfishes (1925). Hosts of shorter papers were constantly appearing from his pen.

Eigenmann's scientific work did not prevent him from rendering great service to Indiana University. A list of his students who have attained fame in American zoölogy is sufficient to demonstrate this. In 1895 he founded the Indiana University Biological Station at Turkey Lake (now at Winona Lake) and remained its director until 1920. In 1908 he organized the graduate school and was its dean until his death. Many scientific honors came to him, most notably membership in the National Academy of Sciences—the only man in his state so honored. He was recognized as one of the foremost ichthyologists of the country and indeed we may place him as one of the four greatest of his time.

But one does not think of honors when thinking of Eigenmann. A kindly man with a heart of gold, with sympathy for everyone, jolly, yet stubborn and with a will of iron in carrying out that on which he had set his mind—this was Eigenmann. No professor was ever more beloved by students and colleagues alike; few will be so kindly remembered.

His health broken by his arduous explorations, Eigenmann was taken to his old haunts in Southern California in 1926, but even that mild climate could not revive him. He passed away, after a long illness, at Chula Vista, in San Diego County, April 24, 1927. He lies at rest in San Diego, overlooking the waters he knew so well many years ago.

Eigenmann has passed, and there is no one to fill his place. A great void is left, but his indomitable spirit will live on in the memory of those who knew him. And over those who in the years to come will study the fishes of the dark rivers of Guiana, the mighty flood of the Amazon, and the rivulets and torrents of the Andes from Bogotá to Valdivia, the great and benevolent shadow of Eigenmann will ever fall.

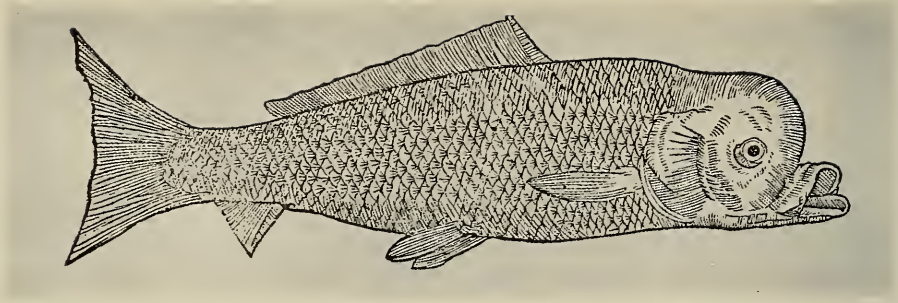


Fig. 1.—The earliest recorded (1554) case of pug-headedness in a fish. Note the steeply rounded forehead and the short, upturned snout with jaws wide open. But for details in the drawing and engraving this might be a modern figure, so accurate is it

Guillaume Rondelet's Pug-headed Carp

THE EARLIEST RECORD—A. D. 1554

By E. W. GUDGER

Bibliographer and Associate in Ichthyology, American Museum

AMONG the numerous and curious malformations in fishes, and one which is universally interesting without exciting the feeling of repugnance commonly aroused by abnormalities in general, is that relating to the shortening of the head and curvature of the snout in fishes. This curious teratological structure, which forms the subject of this note and is shown in Fig. 1, is that designated by the terms "Bulldog-head," "Pug-head," "Lion-head," "Tête de Chien," "Mopskopf" and "Löwenkopf" in the English, French, and German languages respectively.

Years ago in searching through the early literature of ichthyology for other matters, I ran across the case in hand and made a note of it. So far as I know this is the earliest figure and record of this phenomenon, which, imbedded in the old book now to be cited, is practically lost to the science of teratology. So, since it is an interesting thing in itself, and since it is the first record, it seems well to bring it out of its obscurity.

In the year 1554 there appeared at Lyons, in France, a work which laid a solid and sure foundation for the study of fishes. This was a small-sized folio bearing the title *Libri de Piscibus Marinis* and the author was Guillaume Rondelet, regius professor of medicine at Montpellier. Bound with this, bearing the same date, and in effect a second volume of it, is his *Universæ Aquatilium Historiæ Pars Altera*. In this whole work are figured and described 197 marine fishes from the Mediterranean Sea, and 47 from neighboring fresh waters. On page 154 of the *Pars Altera* is the figure and description of the curious fish herein referred to.

Rondelet recognized this as a carp, *Cyprinus* (presumably of the species *carpio*) but, as he had never seen such a fish before, he thought it a new and unusual form or species and accordingly he made the heading for his Chapter VII read "De Cyprini mira specie"—"concerning a carp of an unusual species." Of it he says—"I ought not and indeed cannot pass by in silence a strange species of *Cyprinus*

which was purchased alive in a fish market in Lyons." He then goes on to show that his fish is undoubtedly a carp, but is very different from the others which he had studied and figured. He compares its head to that of a dolphin (the mammal, not the fish), and says that it is accurately shown in the figure.

The figure is indeed an admirable one, and worthy of being brought to the attention of the scientific world. It speaks well for Rondelet's accuracy of observation and for the skill with which his artist and engraver portrayed the actual fish. In all but the details it might be taken for a modern figure.

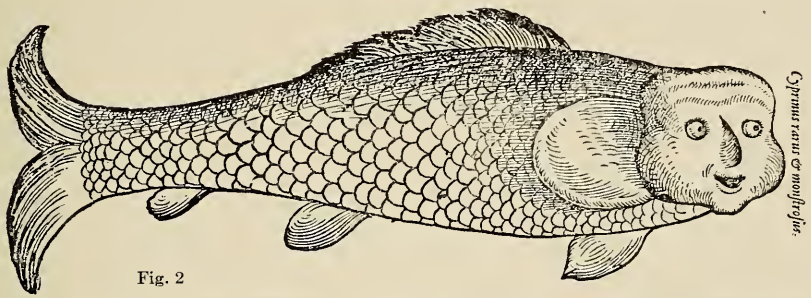


Fig. 2

Gesner's (1558) monstrous carp. Apparently this is a case of round-headedness rather than pug-headedness. The artist has taken great liberties with his subject and, instead of showing the fish in lateral view, has drawn the body in side view, but has figured the head as if turned at a right angle to the body as in an animal having a neck

Conrad Gesner, the universal naturalist of Zurich, Zwitzerland, in Liber IIII ("De Piscium and Aquatilium Animantium Natura") of his encyclopedic *Historia Animalium* (Tiguri, 1558) quotes Rondelet but does not give his figure, and then proceeds to confuse matters very much. It seems that he had data for four specimens of similar abnormal carps—one taken in October, 1545, from a small river (the Eirs) near Retz in Austria: another captured in Lake Constance near Retz in November, 1545; a third taken in 1546 in the province of Brandenburg; and a fourth taken in February, 1554, and kept alive for nine days in a fishpond. Of these fishes, two specimens (numbers 1 and 4) actually came into his hands, presumably as dried skins (since that was about the only method of preservation in those days) and probably stuffed. From the fact that numbers 1 and 2 were both taken near a city called Retz and in the same year (1545) and but one month apart, one might conjecture that the two fish might be one, but the names of the donors are given and plainly indicate that there were two separate fish.

Furthermore, Gesner had sent to him paintings of fish numbers 1 and 2. Which of these he reproduced cannot be definitely determined. Possibly he had a figure drawn which embodied features of both paintings and possibly of the (dried) fishes also. This figure (my number 2) is a veritable monstrosity. The fins and especially the tail are poorly drawn. As to the head, one hardly knows what to say. It is conceivable that it is a bulldog-fish which instead of being drawn in profile, is figured as having the head turned quartering to the right. It is also possible that Gesner is portraying here what is called "round-headedness" in

fishes which is defined by the best authority as a condition in which "the skull is more or less sharply humped upward in the frontal region so as to present a somewhat prominent brow or forehead . . . [while] the lower jaw does not project markedly beyond the upper one." In any case, unlike Rondelet's accurate figure, Gesner's portrayal has no scientific value, as may be seen on inspection of Fig. 2.

A brief explanation is in order as to the cause of pug-headedness. It seems probable that this deformation arises in the course of development from some germinal defect—which is just another way of saying that we do not really know the cause. Strange to say this abnormality has been found to be inherited in some fish in the third and fourth generations. One experimenter by breeding two "puggy" fish obtained normal young. On interbreeding two of these normal fish, "puggy" grandchildren were obtained. Similar interbreeding of normal fish of the third generation gave a number of fish resembling their "puggy" great-grand parents. However, so far as I know, these experiments have never been duplicated.

NOTES

CHARLES W. MEAD
1845-1928

On February 3, 1928, the American Museum suffered a severe loss in the death of Charles W. Mead, honorary curator of Peruvian archæology since his retirement in 1925. Mr. Mead entered the service of the Museum as cataloguer in the department of anthropology in 1897, but later, because of his detailed knowledge of South American archæological collections, particularly those from Peru, was placed in charge of these and remained so until his death. The scientific and administrative staffs of the Museum, at a special meeting, held February 4, 1928, expressed their sense of loss in the following resolution:

RESOLUTION

The members of the Scientific and Administrative Staffs and of the Department of Anthropology of the American Museum of Natural History, here assembled to note the passing of Charles Williams Mead, Honorary Curator of Peruvian Archæology and connected with the Museum for more than thirty years, wish to record our appreciation of his sterling personal qualities and tireless and cheerful devotion to his duties.

We also wish to extend to Mrs. Mead, his wife for sixty years, to his daughters and to his grandchildren our deep sympathy.

ASTRONOMY

The Amateur Astronomers Association is gaining steadily in membership and judging by the attendance at the meetings, the programs are proving of great popular interest.

Mr. David B. Pickering, president of the American Association of Variable Star Observers, who spoke January 19, on "The Romance of Variable Stars," stressed the fact that the professional astronomer needs all the latent power in associations like the Amateur Astronomers Association, and especially the observations of the amateur who is studying the variable stars.

At the meeting held on February 2, prizes were awarded to the winners of the Garrett P. Serviss astronomical competition conducted by the *New York Evening Journal*. Dr. E. E. Free, consulting engineer, Dr. Palmer H. Graham, professor of astronomy in New York University, and Dr. Clyde Fisher, curator of astronomy in the American Museum of Natural History were the judges in this competition.

An impressive ceremony took place when Garrett P. Serviss was made first honorary member of the Society. This was especially appropriate since, through his books and lectures, Mr. Serviss has done more in the last forty years to popularize astronomy in America than anyone else.

Prof. Anne S. Young, of Mount Holyoke College Observatory and Member of the Advisory Council of the Amateur Astronomers Association, gave a very interesting talk February 16, on her recent visit to England to see the eclipse of the sun. This was the fourth eclipse she had observed.

On March 16, Prof. Leon Campbell of

Harvard College Observatory will speak before the Association on "What the Amateur Astronomer Can Do."

At the April meeting, Professor Frank Schlesinger of Yale College Observatory will discuss "Life on Mars."

In May, Prof. J. Ernest G. Yalden will talk on "Astronomy in Navigation."

PLANETARIUM IN ROME

"Rome was not built in a day," and Mussolini evidently felt that it is not yet complete, for he has just signed a contract for the establishment of a Zeiss Projection Planetarium in the Eternal City.

Americans may exult over the big refracting telescope at the Yerkes Observatory and the giant Hooker reflecting telescope at Mt. Wilson Observatory, and they may justly take pride in the significant additions to our knowledge gained by our research astronomers by means of these and other equally important modern apparatus, but it should be a matter of chagrin for Americans to realize that they are following the lead of Europeans in the matter of popular education in Astronomy.

Previous to Rome, Moscow had already contracted for a planetarium, and one is already in operation in Vienna, and negotiations are being carried on in several other cities with a view to the installation of this epoch-making apparatus.

In Germany, where this marvelous technical achievement was brought forth, there are thirteen of these instruments in operation. They are located at Munich, Jena, Barmen, Dresden, Düsseldorf, Leipzig, Mannheim, Nuremberg, Aachen, Stuttgart, Hamburg, Hannover, and Berlin.

At Hannover, the dome in which the planetarium is installed is the crown of the administration and office building of the *Hannoverscher Anzeiger*. Independent stairways, and an express elevator holding twenty persons, afford access to the planetarium on the top of this tall building. Especial mention is made of this because it is the only planetarium yet built which involves the same problems as the one planned for the American Museum of Natural History, that is, in which the planetarium will be located on the top of a five-story building, the proposed Hall of Astronomy.

Since returning from my astronomical mission to Europe in 1925, it has been a source of great satisfaction to have my enthusiastic report concerning the planetarium corroborated by professional astronomers.

Professor Max Wolf, director of the Observatory at Heidelberg-Königsstuhl, writes:

> It is this knowledge [of the night sky] which the Zeiss Planetarium imparts; hence the reason of its great success. . . . For me it was certainly one of the greatest pleasures of my life when I saw the Zeiss heavens move above me for the first time. The Planetarium reproduced the aspect of the heavens with amazing fidelity. . . .
>
> The Zeiss Planetarium has, therefore, grown to be a popular means of education almost without parallel in any branch of learning within the history of man; . . .

Professor Elis Strömgren, director of the observatory in Copenhagen, says:

> He who writes these lines certainly does not doubt that Copenhagen will sometime, sooner or later, acquire its own planetarium. . . . never has a means of entertainment been provided which is so instructive as this, never one which is so fascinating, never one which has such general appeal. It is a school, a theatre, a cinema in one; a schoolroom under the vault of heaven, a drama with celestial bodies as actors.

Dr. R. G. Aitken, associate director of the Lick Observatory, writes:

> The Zeiss Planetarium is the most remarkable instrument that has ever been devised to exhibit impressively, and with the illusion of reality, the motions of the heavenly bodies and the phenomena which result from these motions.

In support of my prophecy as to the number of persons that would be attracted to our planetarium, let me state that in one year the planetarium in Berlin has had more than 450,000 paid visitors.—Clyde Fisher.

The Executive Committee of the American Museum's Board of Trustees at their last meeting approved the plan of erecting the planetarium upon the ground in the northeast court of Manhattan Square, from which place it could be hoisted to the top of the Hall of Astronomy when that is built.

CENTRAL ASIATIC EXPEDITIONS

President Henry Fairfield Osborn gave a farewell luncheon February 23 in the Members Room of the Museum to Walter Granger, palæontologist, Leslie E. Spock, geologist, and Albert Thomson, preparator, members of the staff of the Central Asiatic Expeditions, who were scheduled to leave New York on the following day for San Francisco. Other guests were, Director George H. Sherwood, Prof. Charles P. Berkey, Prof. W.

K. Gregory, Mr. N. C. Nelson, Mr. Barnum Brown, Dr. C. C. Mook, Dr. G. G. Simpson, and Dr. Chester A. Reeds. Following the luncheon an hour was spent in a round table discussion of the past and present work of the expeditions. Professor Gregory paid special tribute to Mr. Granger for his excellent collections in the Orient during 1922, 1923, 1925, and 1926, and for his able assistance to Professor Osborn in the preparation of the Titanothere monograph, page proof of which had just arrived. Following the address by Director Sherwood, Professor Berkey, chief geologist, and Mr. Nelson, archæologist of the 1925 expedition, recounted past experiences and gave timely hints to the new members of the staff.

Before sailing from San Francisco on March 2, Mr. James B. Shackelford, photographer, joined Mr. Granger's party. A week later Mr. Alonzo W. Pond, archæologist of the expedition, sailed from Seattle to meet the party at the expedition's headquarters in Peking. Dr. R. C. Andrews, leader of the expedition, is planning to start for the Desert of Mongolia by mid-April.

Dr. Chester A. Reeds, editor of a large number of the Central Asiatic Expeditions' publications, has prepared a circular concerning the seventy-nine preliminary papers and the "Geology of Mongolia," Volume II, *Natural History of Central Asia*, the first to appear of the series of twelve final report volumes. This circular will be sent gratis upon request.—C. A. R.

CONSERVATION

Smoky Mountain National Park Assured.—The most important recent event in the field of conservation is the gift of nearly $5,000,000 to the Great Smoky Mountain Park fund by the Laura Spelman Rockefeller Memorial. This sum, with the money already raised by subscription and an approximate sum by the State and Federal governments, will permit transforming the area from a National Park on paper to a park in reality, and will result in calling a halt on the logging operations that were wiping out the forests whose preservation was the chief reason for making the region a park. The new National Park will include about 700,000 acres. It is said that 300,000 of these acres are virgin forests, the last extensive area of that kind anywhere in the eastern United States. It will also be of importance as a game preserve, especially for the wild turkey, black bear, deer, and elk.

Yellowstone Park Enlargement.—Recent attempts to enlarge the Yellowstone Park, a project that is particularly important in order to provide winter range for the game, especially the elk, driven out of the present park in winter by the deep snows and lack of food, have invariably been complicated by efforts to open up parts of the present park to exploitation. The bill, H.R. 17, introduced by Representative Addison T. Smith of Idaho, in the early part of the present session of Congress, has aroused great opposition, the Bichler meadows in the southwest part of the park being only one of several parts of the park that the passage of the bill could open up to lumbering or reservoir building.

As a result of these protests, two bills, S.2570 and S.2571, have been introduced by Senator Peter Norbeck of South Dakota, as a substitute for bill H.R. 17, and should receive the endorsement of all conservationists since, while adding most of the area the latter bill would include, they preserve intact the present park boundaries. These boundaries have been maintained inviolate for more than fifty years, ever since the park was established, and no proof of any public necessity for breaking them down has been presented by anyone.

Save the Calaveras Groves of Big Trees.—Appeals to the generosity of the public for contributions for saving areas of especial scenic importance have been so numerous of late that there is danger that some of them will fail unless people can be aroused to a realization that these places must be acquired and protected at once if they are to be saved at all.

A new and very important conservation project is the effort of the Calaveras Grove Association (Harriet West Jackson, President, Stockton, California) to save from the lumbermen the famous Calaveras Groves of big trees, which are situated on the west slope of the Sierra Nevada range a little north of the latitude of San Francisco.

This property is in private ownership and a start was recently made to log off the timber. Only its acquirement by the state for a park can save the big trees. Besides two distinct groves of big sequoias a short distance apart, this tract contains some of the finest sugar pine forest still in existence, the saving of which is especially important, owing to the destruction of the sugar pines in the Yosemite National Park. The estimated cost of the

property is $900,000. It is expected that certain state funds will become available to pay part of the cost of obtaining it for a state park, but under the law an amount equal to that contributed by the state must be raised by donation or otherwise. The above society has been incorporated to raise the sum necessary, and merits the heartiest co-operation of those who can afford to help it in any way, large or small.

DEDICATION OF THE NEW SCHOOL SERVICE BUILDING

An impressive ceremony, planned and carried through by Mr. G. H. Sherwood, director of the Museum, and Dr. Clyde Fisher, curator of visual instruction, marked the dedication of the new School Service Building, and the unveiling of the William Henry Maxwell Memorial at the American Museum on January 17. Leaders of education of city, state, and nation united in praising the work of the Museum along educational lines. President Henry Fairfield Osborn presided and opened the program with an address on "The American Museum in City and State." The formal transfer of the School Service Building to the Museum was then made by the Hon. Walter R. Herrick, representing the Mayor of New York City. After President Osborn had accepted the transfer in the name of the American Museum, he invited Dr. John H. Finley, former Commissioner of Education of New York State, to speak on the life and achievements of William Henry Maxwell, first Superintendent of Schools of New York City. Mr. John Greene, president of the Maxwell Memorial Association, then presented the gift of that Association to the School Service Building. After President Osborn had accepted this gift, the auditorium was darkened for a moment. Then a dim light, which brightened gradually, revealed a striking statue of William Henry Maxwell. This statue, of which Charles E. Tefft was the sculptor, is cast in a beautiful green bronze, and is a handsome addition to the School Service Building.

Other addresses were made as follows: Museums as National Assets, Dr. John J. Tigert; The Museum and the State, Dr. Charles C. Adams; The Museum and the City Schools, Dr. William J. O'Shea; The American Museum's School Service, George H. Sherwood.

Music was furnished by the Dewitt Clinton High School Orchestra assisted by the Euterpe Club of Washington Irving High School.

At the close of the program the guests inspected the new School Service Building.

EDUCATION

Dr. John J. Tigert, United States Commissioner of Education, pays tribute to the Museum's educational work in his February News Bulletin. He says in part,

Museums As an Aid to Education

The City of New York has recently built and dedicated to the service of public education a School Service Building. This building is a four-story and basement structure, 160 feet long and 90 feet wide. It is especially designed and equipped to house the school service unit of the American Museum of Natural History, and to facilitate the various educational activities which have been successfully carried on by it for many years.

New York has demonstrated that the Museum can be utilized effectively as an aid to education. Not only are pupils sent to the Museum for first-hand experience in this treasure house of knowledge, but an extension and messenger service has been maintained which brings to the various classrooms of this great city the nature-study collections, the slides, the films, the picture and library exhibits which the teacher may need to vitalize and objectify her teaching.

These extra-mural activities of the Museum have increased rapidly, and they suggest a way of making available to the children of our farms and other isolated sections the enriched education made possible by experience with museum collections. If State departments of education should develop large central museums the various materials and exhibits could be sent out from them to the various schools when needed. There is a great need of teaching in terms of things rather than abstractions and the wealth of the museum could be made available to all instead of being restricted to the few if the example of this great city museum were followed. The museum is assuming a rôle in public education similar in importance to that of the library and, as education becomes more and more a matter of real things and life situations, its use for educational purposes increases.

The Department of Superintendence of the National Educational Association held its midwinter meeting February 25–March 3 in Boston. Mrs. Grace Fisher Ramsey, associate curator of the department of public education, represented the Museum at this conference. On February 25 Mrs. Ramsey attended the annual meeting of the National Council of Supervisors of Nature Study and School Gardening, and on the following Monday and Tuesday the sessions of the National Academy of Visual Instruction, where she spoke on the supple-

mentary relationship of the educational work of the Museum to that of the schools.

MAMMALS

The Stoll-McCracken Siberian-Arctic Expedition of the American Museum.—On February 11 the schooner "Effie Morrissey," under command of Capt. Robert A. Bartlett, left New York for Seattle by way of the Panama Canal. The Museum is represented by H. E. Anthony, curator of the department of mammals, who is in charge of the scientific party, E. M. Weyer of the department of anthropology, F. L. Jaques and A. Johnston of the department of preparation.

The expedition is financed by Mr. Charles H. Stoll of New York City. Mr. Harold McCracken, the leader, has had considerable experience in Alaska and spent several years there engaged in photography and the collection of data for lectures and writing. Part of the personnel will join the "Morrissey" at Prince Rupert, British Columbia, about the middle of April, and the last of the party will go aboard at some point on the Alaskan peninsula.

The purpose of the expedition is to secure specimens of mammals, birds, fishes, reptiles, insects, plants, and archæological material at various points in Alaska and Siberia. Among the hoped for achievements are the securing of groups of the Pacific walrus, sea otter, ribbon seal, sea birds from one of the islands in the Bering Sea, a bowhead whale, and possibly a hairy mammoth frozen in the ice. In addition to exhibition material, it is expected that large and valuable collections will be made of specimens for the study series. It is hoped that the archæological investigations will shed some light on the human migrations back and forth across the Aleutian chain, and any important clues bearing on this question will be investigated.

After visiting several collecting sites in Alaskan waters, the expedition plans to move over to the Siberian side and make collections from Kamchatka northward through Bering Strait and west at least as far as the mouth of the Kolyma River and possibly even to the mouth of the Lena River. The field selected by the expedition is a very rich one and but poorly represented in American museums.

Throughout the entire cruise special attention will be devoted to the collecting of porpoises, dolphins, and the smaller cetaceans, since these northern waters are a favorite haunt of these marine mammals, and the schooner will be well equipped for taking care of this type of material.

The expedition plans to return about the first of November.

The Vernay-Faunthorpe Expedition.—Arthur S. Vernay who, accompanied by Col. J. C. Faunthorpe, for some time has been making collections of rare specimens of Asiatic mammals for the American Museum and who sailed in November for Burma to secure, in particular, the *Rhinoceros sondaicus*, a small, one-horned species which is almost extinct, has forwarded a cable to the Museum announcing that the party has been unable to locate any specimens and it is thought the animal is extinct. He further stated that all game was very scarce and the jungles almost impenetrable.

Messrs. Albert Butler and Clarence Rosenkranz, from the department of preparation of the Museum, who accompanied the expedition as far as India to secure accessories for groups and color sketches for backgrounds, have been most successful. The members of the party will soon return to New York.

The Lee Garnett Day Roraima Expedition.—The members of the expedition to Mount Roraima which was financed by Mr. Lee Garnett Day have recently returned. Mr. G. H. H. Tate, of the Museum's department of mammalogy, in describing his experiences, says:

Alas, the reputation created for that unusual mountain by Sir Arthur Conan Doyle in his *Lost World* is utterly ruined. Not a trace of a dinosaur exists; even their distant relatives, the lizards, shun the inhospitable plateau.

More than eight thousand feet above sea level, mist-bound, and lashed by cold rains almost the year round, Roraima's twenty-odd square miles of rocky waste cannot reasonably be expected to maintain a teeming fauna of Brontosauri and pterodactyls. In truth, the scant, wiry plant-growth of the rifts and hollows seems barely sufficient to feed the one hundred and twenty kinds of living creatures —most of them insects—encountered by us.

The mist is most exasperating. A rent in the fog lets through a few rays of sunlight. Ensues a frenzied scramble over slippery rocks lugging "Graflex" or "movie" camera toward some much desired subject. You may even succeed in setting up your machine before the clammy, gray blanket blots out the scene once more.

One never escapes from that just-around-the-corner feeling. Even though one is fully aware that no startlingly spectacular creatures can possibly exist on the mountain, the feeling persists that perhaps just beyond. . . .

The fascination of invading a tableland,

utterly unexplored except close to the place of ascent took hold of us. And indeed we made most interesting discoveries there: perfectly preserved ripple marks in the sandstone; a probably new flycatcher; an undoubtedly new burrowing mouse; a St. John's-wort apparently confined to the great crevass at the center of the mountain-top; and, unquestionably, a number of undescribed forms among the invertebrates.

The most important part of the vertebrate material had been expected from the cloud forests at the foot of the precipice. We obtained representative collections from this zone only with great difficulty for, a few years before, forest fires had swept the slopes, leaving but a few wooded patches in the deeper gullies. A considerable portion of our birds and mammals we found at the southeastern foot of the mountain.

The journey northward from the Amazon had not been without incident. Mr. Carter while in quest of birds caught sight of a jaguar feasting on a freshly killed colt. He stalked the animal, and from behind a tree only some fifteen feet away killed it with buck-shot.

More than one specimen of the giant anteater were taken by members of the expedition. These great creatures have immensely powerful muscles, and are armed with large curved claws with which if the need arises they can do much damage. When trying to escape they achieve a clumsy gallop that often tests the hunter's running powers to the utmost.

One night I had the unforgettable experience, while passing along a narrow forest trail, of almost stepping on a bushmaster four feet seven inches long. The dry rustle of his vibrating tail first warned me of his presence. Behind me, on the very spot where I had stepped a few seconds before, now lay a mound of snake half a foot high.

Equally memorable, and the reverse of disagreeable, was our association with General Candido Mariano Rondon, a prominent figure in the field of Brazilian exploration. The General, with his staff, was conducting a separate expedition to the northern frontier. We arranged to join forces for the northward march, and thus my companions and I enjoyed the society and counsel of General Rondon and his officers for many days.

The collections brought back to New York comprise more than 1250 birds, 550 mammals, 500 sheets of dried plants, over 100 reptiles (the South American rattlesnake, *C. terrificus*, is quite abundant on the savannas about Roraima), amphibia, and fishes, several hundreds of insects and other invertebrates, representative rock specimens, moving pictures, and numerous photographs.

In addition to the new forms already mentioned, the collection includes a dozen specimens of the rare honeycreeper, *Diglossa major*, nearly fifty examples of a mouse, only one specimen of which has ever been taken before, the graceful Roraima pitcher-plant, giant purple *Utricularias* peculiar to Mount Roraima, and many other forms of animal and plant life either very rare or as yet undescribed.

INSECT LIFE

Curator Frank E. Lutz attended the meetings of the American Association for the Advancement of Science and its affiliated societies at Nashville as a delegate from the Museum. He is a representative of the American Society of Zoologists on the council of the American Association, and was president at these meetings of the Entomological Society of America.

Following the Nashville meetings Curator Lutz went to Brownsville, Texas, where he was joined by Research Associate Schwarz for a short study of the insect life there in midwinter. Brownsville, at the southernmost tip of Texas, is "subtropical" and is the northern limit of a number of animals and plants whose center of abundance is farther south. One of the most spectacular finds was an exceptionally large nest of a wasp that does the unwasplike thing of storing honey. It is the tropical *Nectarina lecheguana*, apparently occurring nowhere else in the United States and known to the Brownsville people as the "Mexican stingless bee." It is not strictly Mexican but ranges at least to the central part of South America; it is not a bee; and two of them demonstrated to the complete satisfaction of Doctor Lutz that they were quite able to sting if sufficiently urged.

REPTILES

New Habitat Group of the Dragon Lizards of Komodo.—On February 1 there was formally opened to the public one of the largest and most spectacular habitat groups in the new reptile hall. The group portrays a dramatic incident in the life of the now famous "Dragon Lizards of Komodo." A pair of the lizards, feeding on a wild-boar kill in one of the sunny valleys of Komodo Island in the Dutch East Indies, are interrupted in their meal by a third lizard of large size which starts forth from a near-by jungle to dispute ownership with the others. A fourth saurian peers out from its den under the roots of a tree, as if wondering whether to take part in the approaching battle.

The specimens and materials for this group were obtained by an expedition under the leadership of Mr. W. Douglas Burden. The dragon lizard, *Varanus komodoensis*, is a large monitor of the family Varanidæ. It is closely related to certain monitor lizards of Australia, especially to giant forms known only as fossils from the Pleistocene of that continent. It is

believed that the latter reached fifteen or more feet in length. *Varanus komodoensis* does not exceed ten feet, but large specimens may weigh more than 250 pounds. It is, therefore, very much heavier than any other living lizard.

The beasts mounted in this very realistic group have a superficial resemblance to dinosaurs. The exhibit includes a large chart showing the relationships of the lizards to the other groups of back-boned animals, including the dinosaurs and man. The chart is illustrated with many sketches of the extinct forms. The latter, arranged as they are beside the Komodo group, become much more like living creatures in the mind of the Museum visitor, who usually thinks of them only as skeletons.

A third part of the Komodo exhibit is an automatic motion-picture projector which depicts on a screen beside the group five of the most exciting minutes in the capture of the giant lizards. This picture was made by Mr. and Mrs. Burden and has become so popular since the exhibition was opened that it has been found necessary to run it only at stated intervals. The group, the chart, and the motion picture show in detail what the giant lizards are, where and how they lived, and in what way they were captured. The exhibit therefore appeals to the student and to the sportsman, as well as to the average visitor.

The group was prepared in the Museum's department of preparation under the direction of Mr. James L. Clark. The lizards were mounted by Mr. J. W. Hope, the background was painted by Mr. A. A. Jansson, and the accessories were prepared by Mr. Paul Niemeyer.

SCIENCE OF MAN

Mr. George D. Pratt has presented to the department of anthropology two prehistoric pieces of pottery from Japan. One of these is a head of a large mortuary statuette, such as are found in prehistoric burial mounds in many parts of Japan. Models of these tombs are on exhibition in the Japanese section where these two pieces of pottery will also be placed.

BOOK REVIEW

Dragon Lizards of Komodo.[1]— Running the eye along a map of the East India Islands, one finds between Flores and Sumbawa a little speck that is labelled Komodo. Of late years this speck has come into prominence as the home of the "dragon lizard," the largest of living lizards. For many years the existence of these animals was unsuspected; the island was uninhabited, visited only occasionally by pearl fishers, and it was through these that eventually came rumors of the presence of huge and terrible creatures, doubtless dragons.

Instigated by these rumors, a Dutch naturalist, Dr. P. A. Ouwens, sent collectors to the island, who returned with a few specimens which he described under the name of *Varanus komodoensis*.

Then came the world war and everything else was forgotten, even the dragon lizards, but after quiet settled upon earth temporarily, a German sportsman visited the island and shot a specimen said to have measured 21 feet in length. In view of subsequent events, Mr. Akeley suggested that this lizard was probably measured after the method customarily used on sharks and crocodiles, and that the specimen was 10 feet 6 inches from nose to tail and 10 feet 6 inches from tail to nose—21 feet in all. Even 10 feet 6 inches seems to have been rather a strain on the animals. It is a well-known fact that no matter how big a beast is, he will usually shrink before the application of a two-foot rule, and out of the fifty-four specimens that came under the observation of R. E. Dunn, the herpetologist of the expedition, only one reached a length of 9 feet. But a lizard 9 feet long, weighing 200 to 250 pounds, with steel-like muscles, sharp claws, and powerful jaws, is no mean antagonist.

Naturally examples of these rare and monstrous reptiles were greatly desired by museums, but who was the Saint George to go in quest of them? Aside from the cost of the expedition, which would be considerable, the distance was great, the conditions to be met unknown, the possible danger from the animals themselves uncertain.

The answer to the query was made by Mr. Douglas Burden, a young man with sporting tastes, a real interest in natural history, and experience in collecting in tropical climates. As it turned out, the climate was the least of the troubles, for Mr. Burden records that it was all that could be desired, and had it not been for the ants, life would have been very pleasant. Mr. Burden organized and fitted out an expedition that should not merely obtain specimens of the dragon lizard, but also information in regard to their haunts and habits. So he took with him Mr. Dunn, a

[1] *Dragon Lizards of Komodo:* An Expedition to the Lost World of the Dutch East Indies. By W. Douglas Burden. G. P. Putnam's Sons, New York. 1927.

well-known herpetologist, and a "movie" photographer, while Mrs. Burden, who was a member of the party, was a skilled still-photograhper.

How Mr. Burden went to Komodo by way of China, how the party shot, trapped, photographed, and studied the dragon lizards, together with the many interesting events that took place not only during the stay on Komodo, but in going and coming, are well told in his story of an expedition to a lost world.

If the reader wishes to see some of the results of the expedition, he will find in the Hall of Reptile Life in the American Museum a group portraying the lizards in their most picturesque surroundings, while near by a reel of motion pictures shows them as Mr. and Mrs. Burden saw them in real life. And as one watches these big beasts stalking through the grass, or tearing out the bait, he may well imagine that the geological clock has turned backward a few million years and that he is having a glimpse of a lost world. And, besides this, Mr. Burden sent home two living specimens that for a time graced the New York Zoological Park.

If anyone thinks that this expedition was merely a sportsman's trip to secure a few trophies, he will find that, due to Mr. Burden's interest in science, Mr. Dunn, who brought the living animals to New York, has prepared a chapter in this interesting volume in which is summarized what we know to date of the giant lizards of Komodo.—F. A. L.

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Beginning with the MARCH-APRIL NUMBER

Natural History will no longer present a series of special numbers, but will, instead, publish issues containing articles covering a wide diversity of subject matter. The March-April number itself will contain articles on the following subjects:

"The Natives of Australia's 'West'" by Clark Wissler.
"Rivers That Flow Underground" by Chester A. Reeds.
"How Central Asia Travels" by William J. Morden.
"Symmetry in Nature" by Herbert P. Whitlock.
"Some Mistakes of Scientists" by Frederic A. Lucas.
"A Thousand Miles of Coral Reef" by Roy Waldo Miner.
"Little 'Beasts of Prey' of the Insect World" by Frank E. Lutz.
"The Caves of Mt. Elgon" by James L. Clark.
"Native Dwellings of North America" by Pliny E. Goddard.

The cover design of the magazine will be a painting of the head of an Australian native by Arthur A. Jansson, and the entire magazine will be more lavishly illustrated than heretofore.

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ATTENDANCE.—Some idea of the increasing influence exercised by this institute may be gained from the fact that more than 2,292,876 persons visited the Museum's exhibits for study and recreation in 1927 as compared with 2,070,265 in 1926 and 1,775, 890 in 1925. All of these visitors had access to the exhibition halls without payment of any admission fee whatsoever.

The **EXPEDITIONS** of the Museum for 1927 have been world-wide, and have contributed a wealth of scientific information which is being disseminated through the Museum publications. Some notable field work accomplished during 1927 is:

Asia: Faunthorpe-Vernay collection of South Asiatic mammals; Central Asiatic Expeditions' reconnaissance work on fossil sites in Yunnan Province and Southern China.

Africa: Ruwenzori-Kivu distributional study and collections of birds and animals by J. P. Chapin and DeWitt Sage; Taylor-Sudan mammals, birds, and fishes for exhibition material; Eastman-Pomeroy-Akeley Expedition completed the first definitely planned and financed expedition for African Hall material, making possible the starting of this Hall; Martin Johnson completed a four-year expedition photographing African wild life.

North America: The Childs Frick expeditions for vertebrate fossils in the western part of the United States, and to the Gaspé Peninsula for mammals; Roy Waldo Miner's studies at Mt. Desert Biological Laboratory for the new Darwin Hall; Chester A. Reeds' continued observations of the glacial clays in the vicinity of New York City; Van Campen Heilner's trip to King Cave, Alaskan Peninsula, for the big Alaskan brown bear; G. Kingsley Noble's expedition to the Ozark Mountains of Missouri for blind salamanders; Archæological Excavations carried on in New Mexico.

Canal Zone: Dr. Frank Chapman completed data for the new Barro Colorado Island bird group; The Griscom-Crosby Expedition collected a valuable series of birds at the Pearl Islands.

South America: Lee Garnett Day Roraima Expedition explorations and collections in the Mt. Roraima sector of British Guiana and Brazil.

Polynesia: Whitney South Sea Expedition continued its survey of bird life in the South Seas.

SCHOOL SERVICE.—The Museum's service to the schools has been greatly increased by the opening in 1927 of the new School Service Building. The Museum made 10,000,000 contacts during 1927 with the boys and girls in the public schools of New York and its immediate vicinity through lectures on natural history especially designed for pupils and delivered both in the Museum and in many school centers; through its loan collections, or "traveling museums," circulated among 495 schools, and studied by 1,722,433 pupils. During the same period 921,811 lantern slides were lent by the Museum for use in the schools, making 6,866,112 contacts with the million pupils in New York City schools. A total of 3,301 reels of motion pictures were lent to 122 public schools and other educational institutions in greater New York, reaching 1,123,704 children.

The **LECTURE COURSES,** some exclusively for members and their children, others for the schools, colleges, and the general public, are delivered both in the Museum and at outside educational institutions.

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The **SCIENTIFIC PUBLICATIONS** of the Museum, based upon its explorations and the study of its collections, comprise the *Memoirs,* of quarto size, devoted to monographs requiring large or fine illustrations and exhaustive treatment; the *Bulletin,* issued since 1881, in octavo form, dealing with the scientific activities of the departments, aside from anthropology; the *Anthropological Papers,* recording the work of the staff of the department of anthropology; and *Novitates,* devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters.

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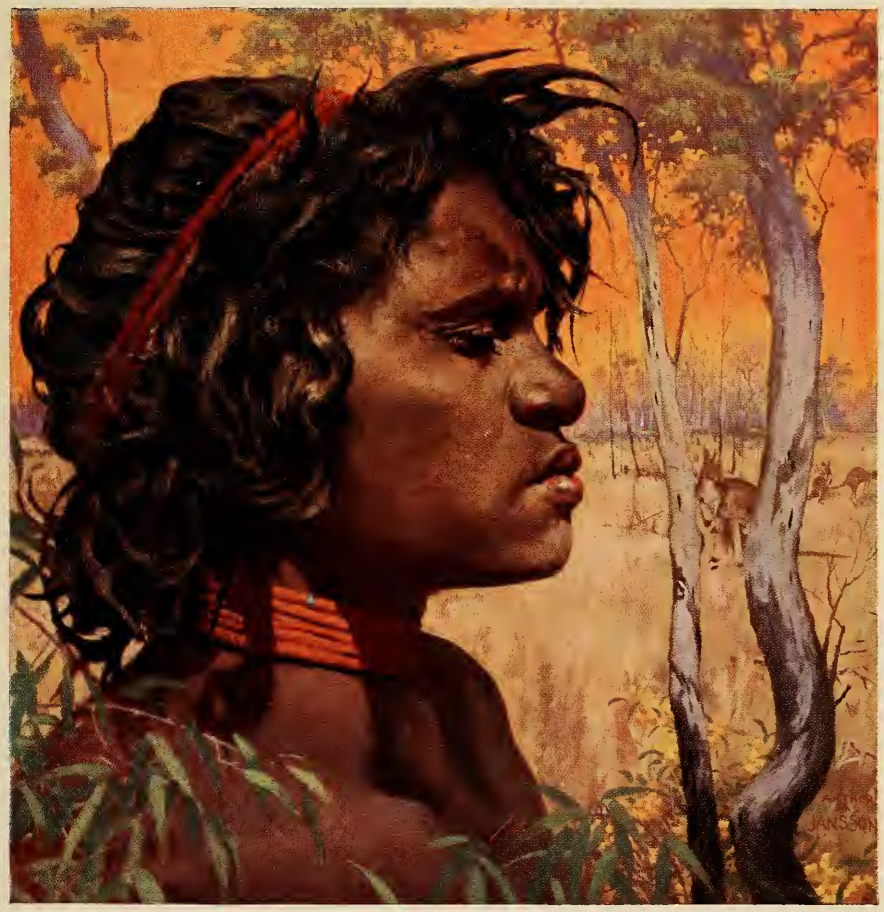

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NATURAL HISTORY

MARCH-APRIL
1928

The Journal of The American Museum of Natural History

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Editor

A. KATHERINE BERGER
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Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

AN AUSTRALIAN NATIVE IN CEREMONIAL DRESS

This extraordinary mask and headdress, as well as the design on the chest and arms, is made of tufts of cotton from a wild plant, stuck in place with human blood. Blood for this purpose is drawn from veins in the arms and applied to the skin with a small brush; the cotton is then stuck on and held firmly in place by the coagulated blood

VOLUME XXVIII

NATURAL HISTORY

NUMBER TWO

MARCH-APRIL, 1928

THE NATIVES OF AUSTRALIA'S "WEST"

An Anthropologist's Account of the Native Australian Blacks

By CLARK WISSLER

Curator-in-Chief, Division of Anthropology, American Museum

IN Australia the natives are called "Blacks," and most people seem to have the idea that the ways of the Australian native are decidedly "dark." At least everywhere we find him cited as the lowest of the low. Ask anyone where the lowest savages are to be found and the chances are that the answer will be "Australia." However, white people who live among these Blacks often come to have a high regard for them and rise to their defense when such statements are made. It is true that when the first Australian settlers came in contact with the Blacks, they saw them as a naked, repulsive people, having no permanent abodes and given over to practices that offended. Naturally, the whites were shocked, and reacted in a way that calls to mind the story of a British colonial official who wrote in his report under the heading, Manners and Customs: "Manners none, customs nasty." But as is the case with all savages, the Australian Blacks improve on acquaintance and show themselves able to learn many things that other peoples do.

In 1925 I spent a few months in Australia, and, setting out from the city of Adelaide, made a quick trip westward to the edge of the open country, the present frontier of Australia. To realize what this means, think of St. Louis in 1865, when a journey of a few hundred miles to the west and north would have taken one through a fringe of villages and farms, fading out into an unsettled country in which roamed hostile Indians. What St. Louis was then to our frontier, Adelaide is to the Great West of present-day Australia. True, you can now cross the southern part of the Australian waste by rail, but so could one have gone from St. Louis to the Pacific after 1869. In either case the traveler would, for the most part, have launched out upon miles and miles of semi-arid plain. In this respect, the parallel between Australia and the United States is close. So today, as one travels west and north from Adelaide, the country grows rapidly dryer, water becomes scarcer, soon bringing one to the great sandy plains, where roam tribes of Blacks who are still to see their first white man,

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

AIDS TO BEAUTY IN AUSTRALIA

The nosebone is widely used as an article of adornment, and the scarifications shown on this girl's shoulder are common among the Australians. Such decorations as these are popular with both men and women

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

AN AUSTRALIAN FAMILY AT HOME

Brush shelters such as this are typical, and this is at least as well equipped as the average. The boomerangs, the spears, the knife, and the few bowls make up all of this family's worldly wealth except for the very important bone decoration that is thrust through the nose of the head of the house

for, as we have said, northward from the trans-Australian railway, to a distance equal to that from Santa Fé, New Mexico, to Medicine Hat, Canada, there are few outposts and no real settlements.

An American student now on the northern edge of this great wilderness writes that he has seen hundreds of natives who never before saw a white man. I was not so fortunate, but only because I did not have time to go the necessary five hundred miles farther to reach the heart of the wild country. Nevertheless, I did meet natives living most of the year by themselves beyond the range of whites.

Our friends in Adelaide, knowing that we were anxious to see the Black in his native country, had arranged in advance for a visit to a sheep station, or ranch, near Tarcoola, about five hundred miles westward, from which it was possible to reach the localities where camps of Blacks were to be expected. Accordingly, we took train at Adelaide, the party consisting of J. Burton Cleland, Brailsford Robertson, T. D. Campbell, and R. H. Pulleine of the University faculty in Adelaide, E. R. Embree and myself, from New York. By special order the train was to stop in the open country at a point near the sheep station where we were to be met by our host. It was early in the morning when we were dropped off with our baggage into the desert sand. No one was in sight. All about us was the stillness of the wild; the conductor waved us farewell as the train pulled out, and we gazed after it with the feeling that the last tie of civilization had been severed. A slight elevation on either side prevented our looking out across the plain, but after an interval we heard the familiar put-put of a Ford—no mistaking it anywhere—and presently two cars came in sight.

NATIVES DRESSED TO RECEIVE WHITE VISITORS

The local missionary had supplied some of the Blacks with clothes. One native woman immediately became the aristocrat of the camp because she obtained a corduroy skirt

They brought our host, Mr. McBride, the manager of the sheep station, and his two lieutenants, whose unfailing hospitality we were to enjoy for the next few days.

After a rest at the ranch house in company with our host, we set out in the two Fords to find a native camp which was said to be about ten miles away The sand was covered with scattered low clumps of blue bush, looking for all the world like sagebrush, with here and there a squat tree, called mallee—the "water tree" of the Blacks. The sun was hot and the pulsing heat waves could be seen when one looked off toward the horizon. As we rode along, we were reminded of the plains of New Mexico and Arizona, so similar were the scenes before us. In the course of an hour, dodging in and about between bushes and trees, and occasionally sticking in the loose sand, we came suddenly upon some natives running about and shouting. They were hastily putting on such old civilized clothing as they had at hand, because, not expecting white visitors, they were following their original habits. Nowadays, all natives are required to clothe themselves when in the presence of white people, so those who do approach the settlements keep at hand at least an excuse for a costume. Some of the Blacks before us, as we saw later, had little more than rags to wrap around their hips. Our host was even more surprised than we were, because where he had expected to find a camp of three or four families, there lay before our eyes the tiny brush shelters of fifty families. It seems that the evening before our arrival at the ranch house, about forty adult men with their women and children, had arrived from the Musgrave Ranges to the northwest, a journey of several hundred

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

SCARIFICATION IS COMMON AMONG THE AUSTRALIAN BLACKS

The ridges, or rolls, in the skin are produced by cuts treated with charcoal so that, in healing, these large raised scars result

PHOTOGRAPHING AN UNWILLING SUBJECT

Professor Pullein is operating the camera. Mr. McBride, the host of the visiting scientists, at his ease in the Ford, is amused at their enthusiasm over the Blacks, to him more trouble than they are worth. A Black boy is trying to comprehend the complexities of the car

Photograph by F. Garnett

MAKING STRING FROM RABBIT FUR

Before the rabbit was introduced to Australia, the fur of native animals was used in the same way. Human hair is also used for strings to make up the girdles, neck bands, head bands, and other parts of what little costume the natives wear

MAKING FIRE WITH A WOODEN FIRE DRILL
This native method of creating a flame is cruder than some similar methods, for the drill is rotated between the operator's palms instead of with a "bow" and cord. These men are in ceremonial dress

miles at best. The purpose of their coming was to perform certain sacred ceremonies and to initiate some of the youths living in the ranch camp; to induct them formally into full tribal citizenship, might be another way to put it. Nothing could have been more to our liking than thus to have the Blacks from the open country meet us half way.

So we stepped out of our Fords into the midst of a camp of Blacks. The reception was friendly, and when a native employee of the ranch explained as best he could that we were Americans living far away, the leading men of the camp shook hands with us, making little speeches, the words of which were meaningless to us, but the kindly import of which was evident.

The accompanying pictures will give some idea of what the camp was like. Whenever the Blacks make camp, they choose the side of a slight elevation or ridge; the reason is not far to seek. All serious ceremonies are for men only. Women and children are not to see them or even to visit the place where they are held, so, as no one can see over the ridge from the camp and the women and children are forbidden to go there, the sacred affairs of the tribe are safe from profanation. It is said that the usual punishment for spying upon the sacred ground is death. Such practices are common to all Australian natives and were known to us. Scarcely had we alighted in the camp, ere men began to approach over the top of this ridge. They were practically nude, but were decorated with paint and white down feathers. This, also, we knew to be the sign that a ceremony was in progress, and that was just the thing we longed to see. Not many white men have been permitted to see the sacred ceremonies of the Blacks, the best descriptions being those in the books of Spencer and Gillen, volumes

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

A TYPICAL PROFILE

This profile view shows the sloping forehead and projecting brow characteristic of Australian Blacks and shows as well one way of dressing the hair

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

HEAVY BROWS AND FLAT NOSES ARE TYPICAL

Australians are bearded and often hairy in body. This native's head appears bald in front, but that effect is artificially produced by pulling out the hair

familiar to all students of anthropology and sociology. When first we saw these decorated figures appear, we exclaimed, "They have stepped out of the book," for though they were not of the same tribes as were studied by Spencer and Gillen, they were closely similar, and in most respects were approximate replicas of the photographs in that book.

Perhaps one reason why the Blacks are considered so low in the culture scale is their simple way of living. They build nothing in the way of houses, merely making a sort of low wind-break of brush in front of which a fire is built at night, for as is the case in all dry countries, though it is hot during the day, the nights are cold. Their fireside furnishings are almost nothing: a digging-stick and a rude wooden dish; for the man a spear, a boomerang, and a short club, a stone flake or two to serve as a knife. These are the essentials. If to this we now add a few scraps of clothing, a tin can or two, a pipe and tobacco, we have listed all that white contact has added. The Black never stays long in one place and without notice may pick up his few belongings and trot off through the brush to a new camp. Nor are his food habits to our taste; when large game fails, which is the rule, he resorts to snakes and insects; then his cooking is little more than a gesture toward the fire. Water is too scarce to wash in, and his hair is never combed. I think most readers will agree that such a life as this is about as near the negative pole as can be.

Yet, your opinion of the Black will rise with acquaintance. He is happy, a good hunter, and above all knows how to live in the desert. Without canteen or water jar, he sets out boldly where a white would not dare follow. It is not merely that he knows where the few water holes are to be found, but that he knows how to

THE CEREMONIAL DANCE BEFORE THE SACRED TREE

The leaders stood in front and the men danced in half-circle formation, moving the feet sidewise

THE CEREMONY BEGINS

Circling clockwise about the decorated tree, the men who take part in the ceremony end by running to the tree and striking it. After the ceremony the decorations are obliterated and marks in the ground around the tree are swept away with the branches of trees. Women and children are not permitted to see the ceremonies

get water from plants. The mallee tree is his canteen. One of the Blacks in camp obligingly dug the earth away from the root of a tree, broke out a section of the root, put one end into his mouth and blew; water trickled out of the other end; by sucking, the water would go into his own mouth. Many of the desert blooms are rich in honey, and taking a note from the bee, the native picks the blooms as he trots along; these serve for both food and drink. These are but a few of the ingenious things the Blacks do, showing that they are far from stupid, and, as we observed, they can be friendly, if they choose.

As I have said, every man in this camp had a long wooden spear; some of these had bone points, but usually the natural wood was merely shaped. These they can throw with force and skill, easily and at some distance killing a man or a kangaroo. Also, each carries in his belt a boomerang and a short club, for killing small game and birds. These they can throw with great precision. There is much misinformation abroad concerning boomerangs, the general belief being that they return to the thrower; but the ordinary boomerang, the one used as a weapon, does not return; it revolves when thrown, and with such force that it can cut open a cheek or thigh if it strikes properly. It is a surprisingly effective weapon. Of course, some boomerangs do return; when we made it understood that we wished to see one, the whole camp was ransacked, only to produce two small, poorly made examples, not at all comparable to the handsome, efficient-looking boomerangs

A CEREMONIAL TREE

On the trunk, painted in red, are the mysterious symbols, the significance of which is known only to those taking part in the ceremony. Women and children are not permitted to see either the tree or the ceremony

thrust under the belts of the men. To be returnable, the two halves, or blades, of the boomerang must be in slightly different planes. So far as we could learn, those of the returnable type were used as toys, because their movements are too uncertain to be depended upon to hit what they are aimed at. However, in hunting water birds, they may be used to drive the flock toward the land and so within reach of the hunter, whereupon the birds are knocked down by the ordinary boomerang. One of the Blacks demonstrated with the returnable one; it sailed around somewhat erratically, circling back, but not quite to the feet of the thrower.

Meanwhile preparations were being made for the sacred ceremonies to be held on the other side of the ridge. In the afternoon the men went to the ceremonial ground, giving us to understand that we could come later. After a time two old men came for us; we walked between them, abreast, while they beat two sticks together and sang songs; four times we paused for a few minutes, approaching the ceremonial place not directly, but circling clockwise. Here we found our friends standing in line around a tree, the trunk of which had been painted, as shown in the photographs. As soon as we were in position, the ceremony proceeded; this consisted of dancing in a circle and finally rushing up to the tree. At the conclusion of the ceremony, certain marks upon the ground were obliterated by the feet and were brushed over with branches of trees, after which we returned to the camp, but not until the leader of the ceremony had laid upon us the injunction that none of their women should be told about what we saw. When back in camp one old Black woman harangued us; all we could make out of it was "that now we should soon

Photograph by F. Garnett

AUSTRALIAN WEAPONS

These natives are demonstrating the use of shields and stone knives. The man at the left is about to throw a boomerang, but the dogs find nothing of interest in this sham battle

die for having gone where we had no right to be."

"But," you may ask, "what was the meaning of this curious procedure?"

That is too much to explain in detail here: Most Australian tribes are divided into family groups, each group having a totem. This totem is usually an animal or a plant, and though not looked upon as a god, yet it holds a serious relation to every member of that group. With the belief goes a ritual which must be observed at certain times of the year. What we saw was the totem ritual of the group whose camp we visited. Similar ceremonies are described in detail in the books of Spencer and Gillen.

The natives were very anxious that we should stay for the festivities of the night —the "corroboree." Many writers speak of the "corroboree" as a sacred ceremony, but it is more in the nature of a social event. It takes place in the camp and all can join in, old and young. Before sunset we returned to the ranch house for a rest, and drove back to the camp after dark. As we neared the camp the Blacks waved burning branches to pilot us to the dancing ground. A space had been cleared of bushes and the roots grubbed up so as not to injure the feet. On the sides, brush had been piled, to be fired for tableaux effects, for what good is a dance, if no one can see it? Some old men sitting in a row on one side motioned me to a seat beside them on the sand. Most of the dancing was by women and girls; without clothing, their dark bodies painted with white lines, they danced in two files, holding their feet together and jumping up and down, in perfect unison, back and forth across the ground. The effect was barbaric but pleasing, and as a dance it was well executed. The old women and men

PART OF THE NATIVE ENCAMPMENT

Showing the sandy-like soil, the low, stunted brush, and occasional trees. These natives were sufficiently sophisticated to own pieces of canvas to cover their brush shelters. The swinging stride of the second girl is suggestive of the walk of occasional negresses in our Southern States

sitting around sang, while two men near me beat time upon the ground with their throwing clubs. After the dance by the women, the men staged a few performances, one of which, representing the capture of an enemy, was especially successful. We greatly admired the way the evolutions were timed in the glare of lights when the piles of brush were lighted, and were sorry when the Blacks announced that the show was over. Unfortunately, no photographs could be taken, for we were without flashlights, but the unusual beauty of that "corroboree" has left a picture in our memories that will never grow dim. That the Blacks enjoyed the æsthetics of the scene we knew from their beaming faces; one of the old men sitting near me knew a few words of English and would frequently turn and say, "Pretty, pretty."

The different races of man have individualities. Experienced travelers feel these distinctions, but always find it difficult to express them. Entering a village of African Negroes, such an experienced person would expect the little community to react to his presence in the characteristic African way; visiting the Eskimo, a different reaction would be expected, but to put these experiences into intelligible words is impossible, because they are matters of feeling rather than of logical analysis. One can, however discuss one experience in terms of the other. Thus, at first sight, the dark color and broad noses of the Blacks remind one of Negroes, but once in their camps the reaction of the group is not at all what one would expect from Negroes. Then, again, it is not like what one expects in a camp of American Indians, but the attitude of the Black is nearer that of the Indian than of the Negro. If, on the other hand, we

compare the attitudes of all three with what we expect when entering a strange white community, then it seems that the Blacks are nearer to the whites than they are to the Negro or the Indian. And this is in spite of the unsavory reputation of the Black—in spite of his revolting practices and his material poverty. He is not so demonstrative as the Negro, nor so stolid as the Indian, but more like a backwoodsman in our own country who meets you frankly on a common plane. This may seem hopelessly contradictory to the reader, but so is the life of the Black—interesting and absorbing in some of its phases, and disgusting in others.

As I have said, the Australian Black is given a low rating in the human scale, probably because he sometimes shocks white people, but a much more serious charge is made against him by cold-blooded scientists. To them, his offensive habits are a matter of no moment, for they see in his bones the marks of our simian ancestors. The portraits accompanying these pages show the Australian head as narrow and long; the forehead is rather low and the brow ridges are bold and heavy, with the root of the nose deeply underset. The profile also shows the mouth thrust forward even more than is usual among Negroes. Finally, the nose is broad and flat. Comparative anatomists look upon certain of these traits as placing the Australian nearer the early ancestors of man than other living races. Nevertheless, the Australian is nearer the European type than the extinct forms of man, such as the Neanderthal, and in that sense is regarded as a modern type. If we

A CLOSE-UP OF A NATIVE HOME

If the native is so fortunate as to secure a piece of canvas, or even some old rags, these may be thrown over the top to aid in warding off the heat of the sun

reduce all this to a simple statement its import will be that the Australian is a suggestion of what all men were at the beginning of the modern period, or to put it another way, in bodily and facial development he has not quite caught up with the other living races.

The reader may have been struck by the heavy beards shown in the pictures. When we look at mankind as a whole, it appears that heavy beards and thick body hair belong to the peoples of Europe, North Africa, Southwestern Asia, and Australia. In contrast, the Negro peoples, Malays, Mongoloids, and American Indians, all have scant body hair and almost no beard. Looking at a map of the world, we observe the zone of heavy beards to run from the British Isles over Europe through Southwest Asia into Australia, while on either side are peoples with very sparse beards. This is a curious geographical segregation of this anatomical peculiarity, the meaning of which is not obvious.

Finally, no evidence has come to hand, indicating that any other people lived in Australia before the Blacks, while, on the other hand, there are indications that they entered the country a very long time ago and that no large amount of new blood ever reached the continent until the period of European settlement. So, for ages, the Blacks lived in relative isolation, untouched by the great culture changes and achievements in Europe and Asia. This may be one reason why they seem to us so barbaric and so crude, so reminiscent of what one conceives the Stone Age to have been.

RIVERS THAT FLOW UNDERGROUND

Unfamiliar Streams That Carve and Preserve Their Courses Through Untold Millenia

By CHESTER A. REEDS
Curator of Geology and Invertebrate Palæontology, American Museum

Till taught by pain
Men really know not what good water's worth;
If you had been in Turkey or in Spain,
Or with a famish'd boat's crew had your berth,
Or in the desert heard the camel's bell,
You'd wish yourself where Truth is—in a well.
—Byron.

PERHAPS the most unique rivers are those hidden away in the depths of the earth. These subterranean streams are of great interest, not only because they have characters peculiarly their own, but since the striking features of their abandoned courses are oftentimes wonderfully preserved in various caves, and may be readily examined. Most of these underground streams join the surface streams before they have attained any considerable size, hence they are usually of short length and have outlets consisting of dark cavernous arches, or, more often, of one or more large springs issuing from the ground.

The subterranean streams of limestone regions are notably variable in their discharge, not only at different seasons of the year, but in different areas. Variability in rainfall is a prime factor. Another cause is the position of the water table—that is, the upper surface of the ground water—with respect to the water levels of former ages. For instance, in a region where the land and the water table have remained constant with reference to sea level, a nearly complete and perfect underground drainage system may be developed with cavernous rock above the level of the underground drainage and a very tight rock below this level. Such a network of joints, sink-holes, and underground passageways lacks storage capacity and discharges its waters swiftly after a rain. Its outlets fluctuate violently, in extreme cases discharging torrents of muddy water in wet seasons and becoming entirely dry in periods of drought. Some of the underground streams and big springs of the Ozark region, Missouri, are of this type.

On the other hand, where a limestone district has subsided, with reference to sea level, great systems of caverns may be submerged beneath the water table and may function as large subterranean reservoirs that equalize the discharge. The underground rivers of this type are perennial and relatively constant, and their springs discharge clear water even at times of heaviest rainfall. The large springs of Florida belong to this relatively constant type.

It is in those caverns which have remained stationary, or which have been elevated with reference to sea level, that the most interesting underground rivers are to be found. The channels of such rivers are far from being smooth, with graded bottoms. They vary from narrow, tortuous defiles to wide and lofty galleries hemmed in by precipitous rock walls. The floor is apt to be uneven, with pits, potholes, and waterfalls occurring at frequent intervals, while sand-strewn and gravelly bottoms are rare. Huge masses of rock, either in place or fallen from the

AN ABANDONED SUBTERRANEAN WATER COURSE

This dry stream bed in the Endless Caverns near New Market, Virginia, shows etched and fluted surfaces on the ceiling and undercut banks in the lower levels

ceiling, may block the way. The roof may grade downward into the water, obstructing farther progress while the stream passes beyond through a submerged tunnel. Along the banks of such a course, reddish clay either of a slippery or sticky consistency remains, following the recession of storm waters. Oftentimes in exploring underground streams one has to lie flat on his stomach and wriggle along on narrow sloping shelves of rock, over an abyss, perhaps, or crawl on hands and knees through cool running water, carrying his candles, provisions, flashes, and camera as best he may. In the darkness of the subterranean world danger lurks near, and it is not advisable to attempt to negotiate such passageways in parties of less than three persons.

In the Endless Caverns of the Shenandoah Valley, near New Market, Virginia, half a mile of the abandoned course of an underground river has been electrically lighted and opened to tourists. The peculiar etchings made by the acidulated waters of such a stream are so well preserved that they appear to have been left only yesterday, yet the growth of many large stalactites, stalagmites, stony curtains, and shields denote that it was many centuries ago. In this same cavern and very close to that interesting grotto known as Solomon's Temple, there is a great chasm. As one looks over the protecting parapet one detects, at the very bottom, the rippling surface of an underground river, that long ago left its former course and now shimmers and scintillates far below in the glow of recently installed spotlights.

In 1925 the writer was one of a party of eight men, five of whom were from the Explorers' Club, New York, who undertook to follow this subterranean river upstream

Photograph by Eugene J. Hall *Courtesy Louisville and Nashville R. R.*

THE RIVER STYX, MAMMOTH CAVE, KENTUCKY

It is estimated that the waters of this river are 400 feet in length by 40 feet wide

and downstream. By means of a rope, the party wound its way down over slippery walls to the clear stream at the bottom. Here the water was cool and shallow, and the ceilings so close at times that we were obliged to stoop. In some places the ceiling was as low as eighteen inches, and the only way we could proceed was to lie flat in the rushing water and squirm along. Then we would come out into fairly large chambers where we could stand up and stretch. It took one and one-half hours to cover two hundred yards in this manner. Progress upstream was stopped by the ceiling descending abruptly into a deep pool of water. It may have been possible to dive under this obstruction, but it was not deemed wise to attempt it before exploring a side avenue. But this was blocked by a growth of huge stalactites and stalagmites, and, after noting raccoon tracks in the red mud, we essayed to return to the point of entry and to proceed downstream in an endeavor to find the outlet. This part of the trip was more interesting, for the chambers were larger and the ceilings were not so low. The red mud, however, was more plentiful and the sloping shelves more treacherous. Twice we reached places where it was impossible to follow the actual stream bed, but in both instances we found passages above which led to the water beyond. After much scrambling we came to a "Fairy Fount," to a perfect likeness of an "Elephant's Head," and to a "Silent Waterfall," over which the stream dropped some ten feet. Having left our ropes dangling at the point of entry, we could not proceed farther, so we placed the following label in a bottle and turned back:

THE MARINE CORRIDOR IN THE ENDLESS CAVERNS

Showing the junction of two abandoned underground stream channels, one to the left and the other to the right of the surveyor's rod. The dark limestone rock in the wall near the foot of the standard has been blasted away to provide a wider passage for tourists

Courtesy of the Ocala Chamber of Commerce

SILVER SPRINGS, NEAR OCALA, FLORIDA

Sufficient water wells up from a submerged cavern 65 feet wide by 12 feet high to form a large river. The lowest registered flow was 342 second-feet in February, 1917, the highest 822 second-feet in December, 1898. A second-foot, that is, 1 cubic foot a second, or 448 gallons a minute, would be regarded as a remarkable spring. One of 822 second-feet, or 368,256 gallons a minute, or 530 million gallons a day, is highly unusual. Only two other springs in the United States, namely, Malade and Thousand Springs, in Idaho, have registered larger flows. The water of Silver Springs has a bluish tinge, but it is so clear that the chalk-white limestone bottom, the aquatic vegetation, and schools of fishes can be seen readily through glass-bottomed boats

This bottle is placed at the farthest point penetrated by members of the expedition of the American Museum of Natural History and the Explorers' Club of New York, May, 1925. If anyone finds it and can carry it still farther, please report to the American Museum of Natural History.

Two hours later we reached the hanging rope and ascended hand over hand into the main passage of the cave, having spent seven and a half hours trekking along the course of the underground stream.

After resting from this hazardous trip, we proceeded to the far end of the tourist section of the Endless Caverns and spent twelve hours exploring unknown passages and another portion of the underground stream. The end of the Caverns was not found, but a second label was left in a bottle where the stream tumbles down over a high subterranean wall.

Although this underground stream was not followed to its limits, a farmer complained, following our subterranean exploits, that his spring had suddenly become riled. I visited the spot, and found four large springs emerging at the head of a deep valley. After a survey of the tourist section of the cavern had been completed, a level line was run from the cave entrance to the springs, and it was discovered that these springs are 11.5 to 13.5 feet below the stream bed at Solomon's Temple.

One of the best known underground streams is River Hall of the Mammoth Cave, Kentucky. It is but a portion of the great labyrinth of cavernous passage-

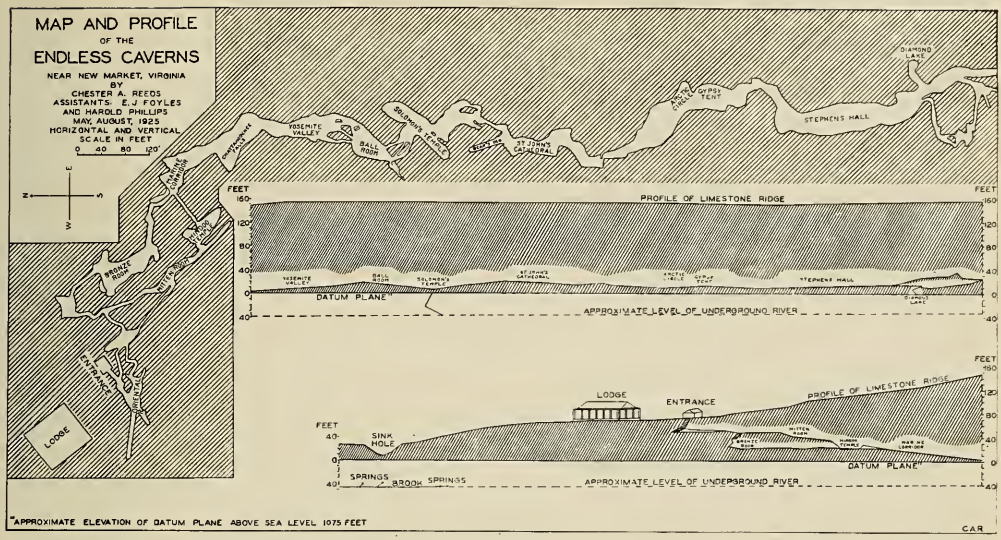
ways, which constitute the lowest level of five successive series of galleries in this immense cavern. This great subterranean watercourse is the gathering bed of the rain waters, which enter the caverns largely through thousands of sink-holes that open down from the surface.

The more prominent water passages of River Hall have received the following names:

A quiet pool of fresh water more than a hundred feet long has been called the Dead Sea. Eyeless fish and other aquatic animals are found in it. Beyond and around a wall of rock may be found the River Styx. The dark waters of this river are estimated to be four hundred feet in length by forty wide. In a lofty and spacious hall beyond the River Styx appear the placid waters of Lake Lethe of about the same size as the Styx. Next follows the Great Walk about four hundred yards in length, with a floor of fine yellow sand five feet above low-water mark and ninety feet below the ceiling. The stream alongside is twenty feet wide and contains the blind white crayfish, *Cambarus pelucidus*. Next comes the calm and unruffled water of Echo River with three arches, through any one of which a boat may be launched. The first arch is about three feet above low water, and if the river has risen, it is necessary to embark from the second or even the third arch, which is thirty feet above the water. Barometer readings indicate that the surface of Echo River is about twenty feet above the level of Green River. Echo River is about half a mile long and varies in width from twenty to two hundred feet between its precipitous walls. Myriads of cavities varying from a few inches to many feet in diameter occur in the enclosing walls. They are in part

FALLEN SECTIONS OF THE CEILING

Huge blocks of limestone, detached from the ceiling, not only retarded the progress of the writer's exploring party in the Endless Caverns, but they hid from view the underground river which flows at a lower level



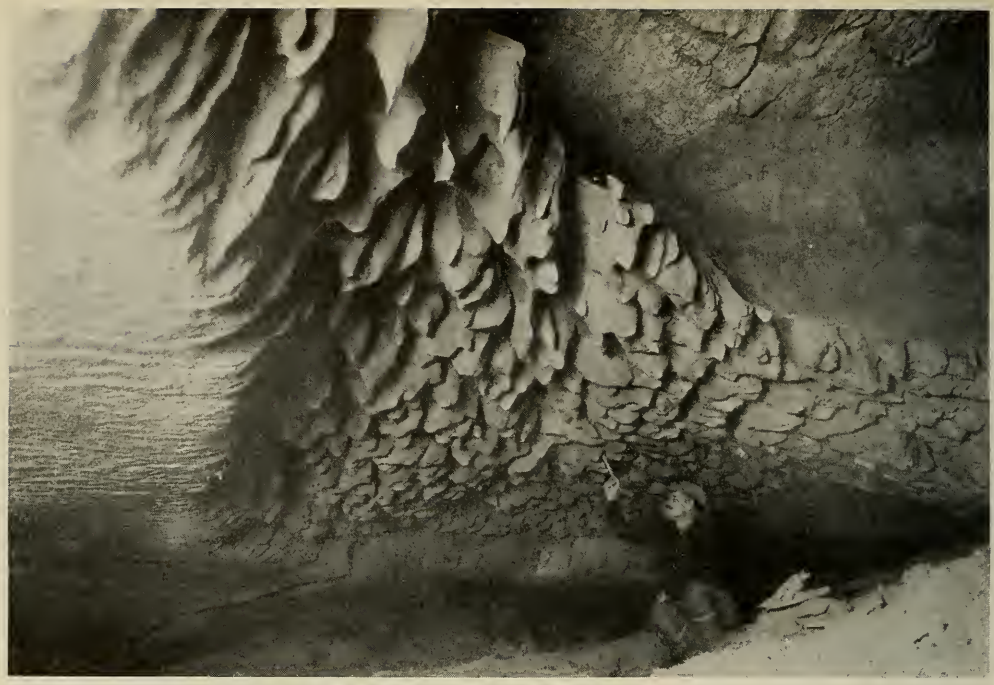
SKETCH MAP AND PROFILE OF THE TOURIST SECTION OF THE ENDLESS CAVERNS
This drawing is by Chester A. Reeds assisted by E. J. Foyles and Harold Phillips. The approximate relations of the underground river and the outlet springs to the electrically lighted portion of the cavern are shown in profile

responsible for the echoes and reverberations developed on this stream. Roaring River appears some distance beyond. It is difficult to traverse, being a succession of shallow ripples and deep basins navigable only by a portable canoe.

When Green River, the near-by surface stream, rises, River Hall becomes flooded, forming a vast continuous channel of water two miles long and varying from thirty to sixty feet in depth. Under such conditions, the River route through the cavern is impassable to tourists. The outlet for such a great volume of water is not definitely known, although deep bubbling pools have been noted along the banks of Green River at various places. It is probable that when engineers of the United States Government make a detailed instrumental survey of Mammoth Cave, including the surface of the ground and the approximately one hundred and fifty miles of passageways underground (a matter which the former owners of the cavern did not permit), we shall have a much better understanding of the movement and the outlets of these subterranean waters.

Other underground streams occur in the United States, but few of them have been explored or described. Reference to them is confined largely to newspaper articles on caves. Some American caverns such as Luray, have no underground streams, but instead, have pools of water beset with beautiful cave formations. The Wind Cave of the Black Hills is a dry cave. In some places, such as Bermuda, caves are found where no streams or wells of fresh water occur. There are, however, many lakes in the Bermuda caverns which show that they are connected with the sea by subterranean passages, because the waters within the caves rise and fall with the tides outside. Many caves in other parts of the world contain underground rivers, but in a brief article such as this, it is possible to cite only a few additional examples.

The celebrated French explorer of caverns, E. A. Martel, in his volumes *Les Abimes* 1894, and *Traite des Eaux Souterraines* 1921, calls attention to a considerable number of underground rivers in Europe, particularly in his native country, France.



AN ETCHED CEILING IN AN ABANDONED WATERCOURSE

These odd features in Endless Caverns are not stalactites or secondary deposits of lime carbonate, but are irregular surfaces of the original limestone rock dissolved out by the acidulated waters as they flowed past thousands of years ago

Ewing Galloway

THE "HINDU TEMPLE" IN THE ENDLESS CAVERNS

Showing the uneven surface of a dry watercourse. Huge stalactites, stalagmites, columns, and stony curtains, all representing secondary deposits, border the ancient stream bed. Joints in the ceiling, some sealed with calcite and others supporting small stalactites, show the places where the ground-water seeps through the limestone rock

Ewing Galloway

"SOLOMON'S TEMPLE" IN ENDLESS CAVERNS

The "temple" occupies a position about halfway along the tourist trail. In May, 1925, the writer's exploring party with supporting rope, entered the dark pit beside the stone balustrade and, after winding down over mud-covered slopes, reached the underground river, a vertical distance of 44 feet

Courtesy of Endless Caverns

A NEAR VIEW OF AN UNDERGROUND RIVER

This stream flows beneath Solomon's Temple, Endless Caverns, Virginia. In the center and right background a great mass of wet flow-stone fringed with drooping stalactites sparkles in the glow of the incandescent lamps. The ground-waters from higher levels are oozing down over its surface to the river

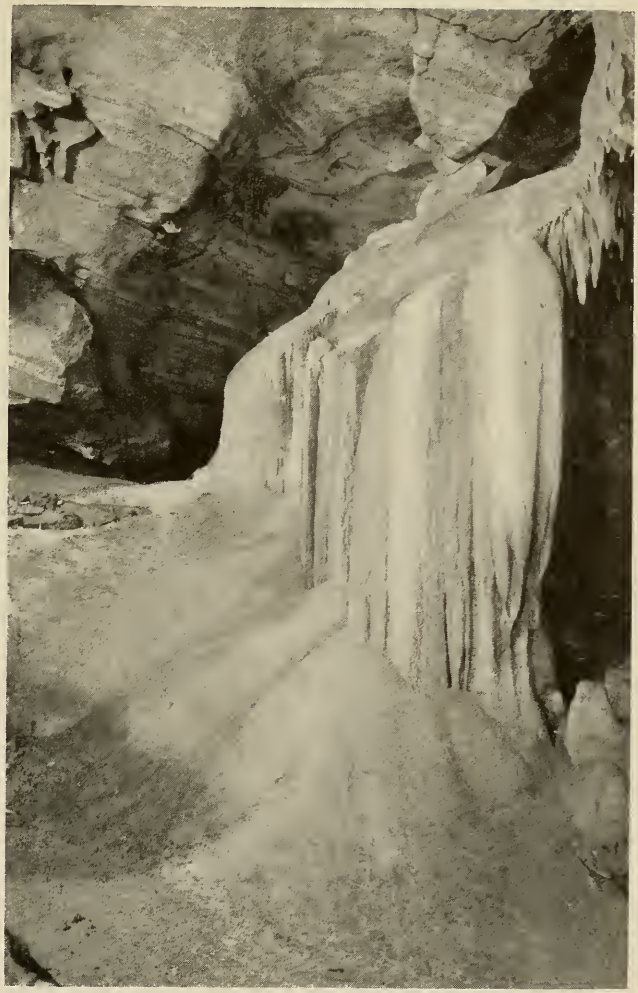
EXPLORING AN UNDERGROUND STREAM
Members of the writer's exploring party clambering down over precipitous and peculiarly carved walls in their endeavor to reach the subterranean river in the Endless Caverns

He states that near the village of l'Isle sur Sorgue, about fifteen miles east of Avignon, the fountain of Vaucluse breaks violently from a rock fissure at the base of a two-hundred meter cliff to form a considerable river, the Sorgue. The volume of water emanating from this fountain head fluctuates enormously from 4500 liters to 150,000 liters a second. Since this water emerges from a natural siphon, which is at least fifty-five meters in vertical depth, and inclined at an angle of from fifty to sixty degrees, it has been impossible to explore the subterranean course of the stream, although the catchment basin for this fountain is seventy kilometers long by five to twenty-six kilometers wide, with more than forty considerable sink-holes or avens in Neocomian limestone.

The Bonheur River in the department of Garol, on the north slope of the Cévennes, disappears into a complicated series of caverns totaling more than 6350 meters, reappearing under the name of the Sramabiau. In the caverns the river divides into three channels, and for about six kilometers its passages are unknown.

In the district of Carniola, Jugo-Slavia, and about a mile from the market town of Adelsberg, is the entrance to the famous stalactite cavern of Adelsberg, one of the largest and most magnificent in Europe. The River Piuka enters the cavern sixty feet below its mouth and has been explored for 2700 meters. After passing through a siphon of 700 meters, the river disappears for 2400 meters to reappear in the cavern of Kleinhaüssel, where its course has been traced for 2500 meters. The total course of this stream underground measured by fairly direct lines, is 8.9 kilometers, or about five and one-half miles. The Magdalene grotto in this cavern is celebrated for the subterranean amphibian, *Proteus anguinus*, which is about a foot in length, has both lungs and gills, and lives on snails and worms.

The Pecca River in Jugo-Slavia, after an open course of sixty kilometers, runs for 300 meters through the cavern of Mahorčič. The stream reappears in an open sink-hole, the lesser doline of Saint-Canzian, and after passing under several natural bridges, it enters a second sink-hole, the great doline of Saint-Canzian. The total open course of the river in the dolines is 400 meters. It then disappears again to follow an underground course, which has been explored for a distance of 2.1 kilometers. The Pecca is a torrential river, and frequently varies several meters in height within a few hours. In 1892 the river rose fifty meters. A total of thirty-six cascades appear along its underground route. After entering the siphon of the cavern of Saint-Canzian the course of the river is unknown, but it is supposed to flow underground to Timavo on the Adriatic coast, a distance of thirty-six kilometers.



Courtesy of Endless Caverns

A "SILENT WATERFALL"

A cascade of "flow-stone" in Endless Caverns over which the lime-impregnated waters flow so gently that not even a gurgle is heard

In the central Peloponnesus of Greece, in the plain of Mantineia, seven drainage basins find outlets through caverns into the gulf of Corinth. Many of the small interior valleys throughout the peninsula have no outlet, except through such caverns. The ancient Greeks paid considerable attention to keeping the mouths of the caverns clean and drainage in good order. Under the Turks, though sporadic attempts were made to clear the encumbered drainage, and grills were kept at the mouths of caverns, the underground courses became so obstructed that malarial marshes formed at the mouths of many of the larger valleys. In the earlier years of Greek independence this condition grew even worse.

The few examples of underground rivers cited from the United States, central France, and southeastern Europe are typical of the karst, a limestone plateau on the eastern coast of the Adriatic. Karst regions are characterized by (1) "lapiez," irregular furrows developed by combined erosion and solution in the rock

Courtesy of Endless Caverns

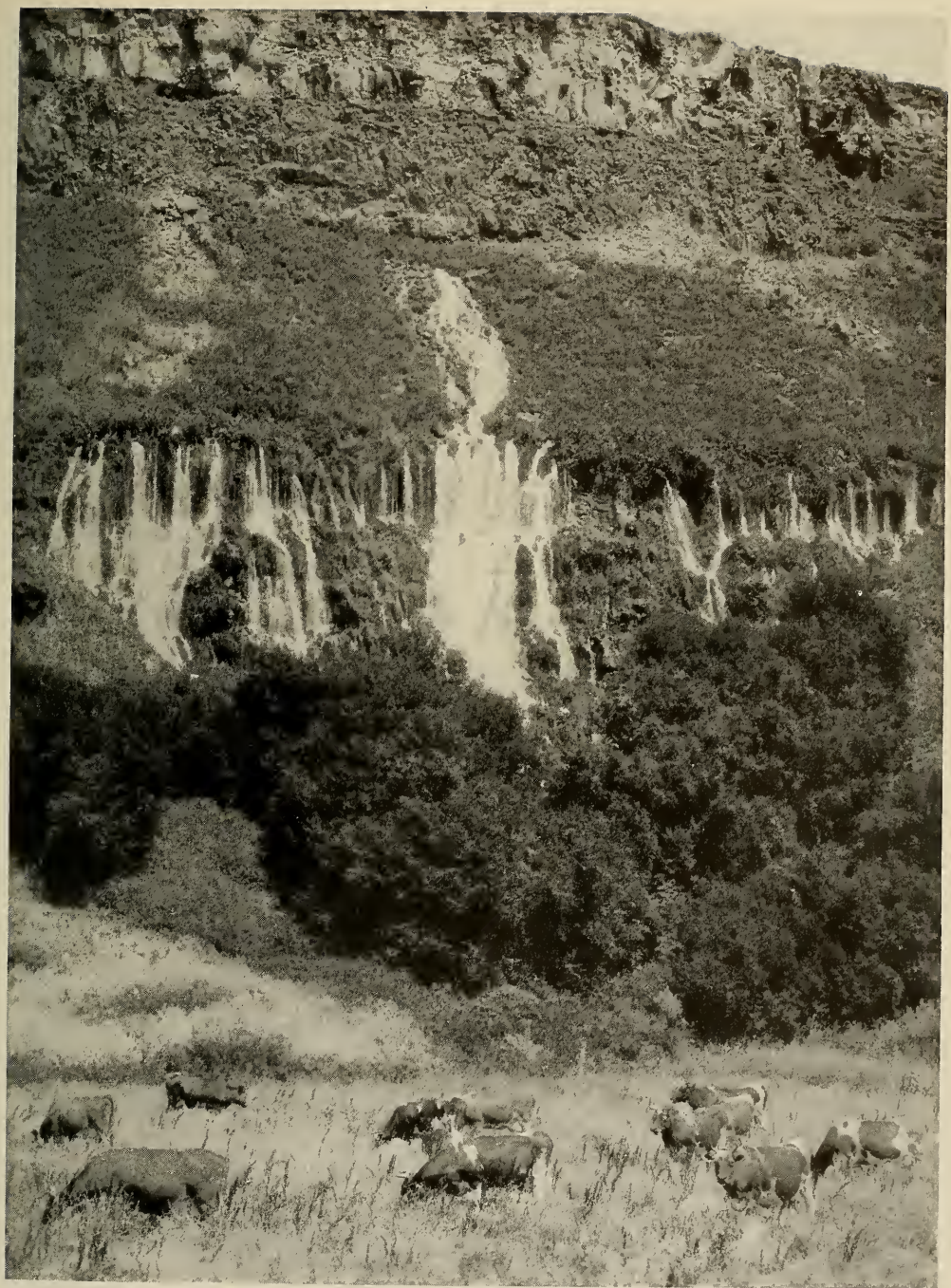
ANOTHER VIEW OF THE UNDERGROUND RIVER IN THE ENDLESS CAVERNS

In addition to the drooping stalactites which reach to the level of the stream waters, others may be seen dangling from rifts in the ceiling. The meandering course of the underground river and the steeply sloping mud-covered banks are apparent

Photograph by Eugene J. Hall *Courtesy of L. and N. R. R.*

"ECHO RIVER," MAMMOTH CAVE, KENTUCKY

Flat-bottomed boats propelled by guides are the only means of transit along the half-mile course of this famous stream. In the right foreground may be seen a huge slab of limestone, broken into various blocks, which formerly occupied a position just below the present ceiling



Idaho State Chamber of Commerce *Courtesy of the U. P. R. R.*

A PORTION OF THOUSAND SPRINGS, SNAKE RIVER, IDAHO

One series of the numerous large springs emerging from the base of a highly jointed and vesicular bed of lava. In 1920, Thousand Springs registered a flow of 864 second-feet or 557 million gallons of water a day

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DREAM LAKE, LURAY CAVERNS, VIRGINIA

Pools of clear water abound in various parts of this cave. The water is so transparent that it is deceptive to most visitors. As may be noted in the left portion of the view, numerous small stalactites are reflected in the waters of the lake

fissures of limestone surfaces; (2) "dc-lines" or "sink-holes," funnel-shaped openings; (3) "ponors" or "avens," cylindrical shaftlike apertures; (4) "uvalas," large depressions of one or more kilometers in diameter; (5) "poljes," blind linear valleys; and (6) "hums," remnants of porous limestone. In the development of these features, the water of a karst region leaves the surface and circulates almost entirely underground. The rivers do likewise, and since karst topographies are developed on limestone and dolomite rocks in many parts of the world, it is in such areas that we should look for underground rivers.

Underground rivers are developed sometimes beneath extrusive volcanic rocks. One of the most striking instances of this kind is to be found in the Snake River basin, Idaho. For forty miles along the cañon of Snake River below Shoshone Falls, where the river has cut through the water-bearing lava beds, many beautiful springs produce a volume of more than 5085 second-feet[1] of ground water, that is, an average of 3280 million gallons a day or almost twice the consumption of water in New York, Chicago, Philadelphia, Cleveland, Boston, and St. Louis, during 1916. In 1920 Thousand Springs, issuing from the rock 195 feet above the level of Snake River, yielded a flow of 864 second-feet. The horizontal beds of lava, which form the surface rim rock, are in part responsible for this tremendous flow of water. They were deposited during the Tertiary and Quaternary periods, and are so vesicular and so broken with joint planes that they absorb and transmit

[1] A second-foot, that is, 1 cubic foot a second, is equivalent to a flow of 448 gallons a minute or 645,120 gallons a day.

Bermuda Photo Service

A GORGEOUS SETTING OF STALACTITES IN A BERMUDA CAVE

The Bermuda caves were formed when the islands stood at a higher level. Due, however, to a subsidence of the islands, perhaps 80 to 100 feet during the Pleistocene or Glacial Period, the lower levels of the caves have been flooded with sea water

water freely. The water comes from the heavy rains and snows which fall upon the extensive lava plateau and bordering mountains during the winter season. The great body of ground water is obviously held up by an underlying impermeable formation, and it is not improbable that these dense rocks constitute a former land surface, and that the principal underground streams, which supply the springs, follow down the valleys of this ancient surface.

In conclusion it may be stated that the amount of ground water within the crust of the earth is enormous, that it occupies great depths, perhaps six miles, and has been accumulating for untold ages. The quantity has been estimated to be nearly one-third the total volume of the oceanic waters. This great mass of water percolates slowly through the porous and jointed rocks to form great systems of underground drainage, and to take part in geologic work of profound importance. Where geologic conditions cause these waters to converge, subterranean streams are formed, but they are as a rule small; large underground rivers are rare and, when discovered, they have attracted wide attention. Underground streams are usually short and the volume of water present is dependent upon the size of the catchment area, the amount of precipitation, and whether the subterranean drainage system is in a youthful or mature stage of development. The rate of discharge of such rivers, especially in limestone regions, is also dependent upon whether the cavernous passageways have subsided, forming storage reservoirs, or whether they have remained stationary with reference to sea level since their formation, or whether they have been elevated, permitting the acidulated waters to etch out new channels at lower levels. The subject is a fascinating one, for it permits a look into Nature's great underground laboratory where waters, charged with all sorts of mineral substances, are circulating in many directions, and performing chemical work of great geologic and economic importance.

HOW CENTRAL ASIA TRAVELS

The Ancient Methods of Transportation That Are Still in Use in the Heart of the Greatest of Continents

By WILLIAM J. MORDEN

Field Associate in Mammalogy, American Museum

FROM the Karakoram Mountains, which mark, roughly, the northern limits of India to the Trans-Siberian Railroad, is about the same distance as from Corpus Christi, Texas, to Winnipeg, Canada. From the Sea of Aral on the west to the eastern limits of the Gobi Desert the distance is about the same as from San Francisco to New York. That portion of the greatest of continents is, then, somewhat larger than the United States, yet within this entire expanse, which is made up of mountains and deserts, plains, oases, and fertile valleys, transportation facilities, in the modern sense, do not exist. Millions of inhabitants obtain their meager livelihoods in hundreds of different ways. Scores of different tribes inhabit innumerable wide-flung districts. Some of the greatest migrations in history and some of the most destructive hordes of warriors have utilized the trails and roads of that enormous land, yet, without exception, migrants, warriors, and tradesmen, herdsmen, hunters, and explorers have been forced to move across mountains and plains and valleys without a single one of the numerous modern methods of transportation without which Europe and America could never have attained their present predominance in world affairs.

Since before the dawn of history this huge section of the interior of Asia has made almost no advances whatever in its methods of transportation. With the taming of yaks and camels and horses their advances in this field seem almost to have ended. Since taking that important step, only a few halting advances have been added, and it is probable that the armies of Jenghiz Kahn, of Ogdai, and Kublai Kahn, and Tamerlane were at least as well equipped, so far as their transportation was concerned, as are the present-day dwellers in the heart of Asia.

During 1926, as leader of the Morden-Clark Asiatic Expedition, I had the opportunity of traversing much of this great area—of living close to the people, and of being able to observe the methods of transportation in common use through thousands of miles of this sparsely settled land. It was not, of course, our purpose to

CENTRAL ASIA

Showing the route traversed by the Morden-Clark Asiatic Expedition from Kashmir to the Trans-Siberian Railroad. The transportation methods of this enormous land are described in the accompanying article

study transportation, but because we had to travel so far, and were forced throughout to utilize the local means of transport, we naturally became familiar with practically all of the methods in present-day use.

The route northward from the Vale of Kashmir into Central Asia leads abruptly upward into and across the Himalaya and through the territories of Gilgit and Hunza, the latter of which lies amid the mighty peaks of the Karakoram Range. During the short summer season pack ponies are the usual method of transport along this route, which is known as the Gilgit Road, though it is but a tortuous military trail that is not adapted for wheeled transport. Owing to the fact, however, that the trail winds among the mountains and over several passes which lie high and exposed to the heavy winter snows, those attempting the journey before the snows have disappeared from the trail must depend for the transport of kit and supplies upon coolies locally obtained.

These men are difficult to hire, owing to the sparseness of the population in the districts traversed and the necessity for every available man to labor in the stony fields at every opportunity. Furthermore, it is not possible, as it is in Africa, to hire men for more than a march or two at a time. The result is that the traveler is forced to hire new coolies at least every day or two, and sometimes he must do so more than once a day. Nor is it possible to obtain any coolies at all without the assistance of the government, for only when the traveler is accompanied by a representative of the local official, who has the power to requisition men from the villages along the route, is it possible to hire them at all. The rates of hire are fixed by the government and average about one cent a mile. More than that, the men feed themselves, carrying in addition to their load a little bag of grain or meal.

One of my most vivid recollections of Himalayan travel is of a long file of gray-

clad figures toiling upward through the deep drifts of the Burzil Pass in the dim half-light of early dawn, with snow-clad peaks showing ghostlike against the gray sky. A bitter wind howling down the pass twisted wraiths of stinging snow into the faces of the sixty struggling men, while their heavy packs, carried, as is usual with all hill people, upon their backs, forced them to bend almost double to negotiate the ascent. Though we had kept our loads at somewhat less than the sixty pounds set as a maximum by the government, a couple of the coolies were completely exhausted by the time the summit was reached, but they both, after a short rest in the snow, gamely arose and carried on to the rest house five or six miles down the farther side.

The coolies of Kashmir carry T-shaped sticks which they use as staffs and also as supports for their packs when making short halts. This ingenious device obviates the necessity for sitting down during short pauses for rest, with the attendant difficulty of again rising to the feet, for the staff can readily be thrust under the load, thus relieving the bearer of most of the weight. For the longer halts, of course, the men drop into the snow and struggle out of their harness. The coolies who do a considerable amount of packing have frames of light wood with the pack ropes already in place. On these frames the packs are placed and lashed fast, the whole arrangement enabling them to handle unwieldy loads with greater ease.

Along the route of our journey of 1926 it was only in the Himalaya and the Karakoram ranges that we found coolie transport in common use, for in the mountainous regions of the Thian Shan and the Altai, animal transport was almost invariably feasible. So far as I know,

KASHMIRI COOLIES ON THE BURZIL TRAIL

These men, loaded with packs weighing up to sixty pounds, are employed at the rate of one half anna—about one cent—a mile. Occasionally one of them travels barefoot, except for rice-straw sandals, and for short rests they support their packs on the T-shaped staffs they universally carry. "Marches" average from ten to fifteen miles

those regions through which we first passed are the only ones in Asia where coolie transport is general.

While it is true that throughout Central Asia coolie transport is not common, all the other means of transportation are certainly primitive enough. The use of pack animals is most widespread, and of the different animals used, ponies, horses, camels, and yaks, with a sprinkling of donkeys, form the major portion. Our first experience with Central Asiatic pack animals was with the little Himalayan ponies, for which we had been warned to provide especially short cinches on our army saddles. It was fortunate that we had done so, for the girth of one of these sturdy little creatures seems to be little more than half that of an average American cavalry mount. Notwithstanding their diminutive size, and their apparent lack of strength, these little beasts carried our kit and ourselves for marches of ten to fifteen miles over rough mountain trails in a manner that surprised us. At first it seemed like cruelty to animals for us to bestride the shaggy little fellows while they struggled along uphill and down, forcing us, now and then, to lift our feet to avoid contact with the bowlders that were in many places thickly strewn in the trail. Before we reached the Pamirs and transferred to the backs of yaks, however, we had come to have a very great deal of respect for the strength and ability of the Himalayan pony.

In the Thian Shan and in other parts of Central Asia, horses somewhat larger than the ponies of the Himalayan districts are common. Several months after leaving the Himalaya our pack train consisted of about thirty Turki horses which, after carrying us through the Thian Shan on a journey of several weeks, ended that portion of our trek by a march of fifty-five miles, which they made in about

THE STEED OF THE PAMIRS IS THE YAK

This animal, while not native to the Pamirs, is widely used there by the Kirghiz who inhabit that inhospitable land. James L. Clark is shown here with his mount in one of the higher valleys

WILLIAM J. MORDEN ON A HIMALAYAN "TAT"

The sturdy little ponies, bred in the mountains and accustomed to the steep and rocky trails, are surprisingly useful. So small are they that the regular army saddles that formed a part of the equipment of the Morden-Clark Expedition had to be specially prepared with short cinches. Yet, despite their limited size, these animals carried their riders for fifteen miles or more a day over the mountain trails without noticeable fatigue

twenty-four hours, including a rest of hardly more than two hours on the way.

If only because they are not to be found outside the higher districts of Central Asia, yaks are likely to attract more than their fair share of attention. This does not mean, however, that yaks do not have characteristics of their own that are interesting—and sometimes maddening. Yaks, of course, are not greatly unlike shaggy, hump-backed cattle, relatives of which they are. But just as other families show wide ranges of temperament, so does this, for certainly no self-respecting cattle ever display such extremes of "mulishness" as yaks are likely to develop upon the slightest provocation. Upon mounting one of these beasts the rider is likely to find that his steed has decided to lie down, though usually it can be persuaded to rise again with a proper application of the stick which is an absolutely essential part of the rider's equipment. Once under way, continued application of the stick is more or less necessary, although when the creature decides to stop, no amount of moral or physical urging will have the slightest effect. On one occasion we had a yak that decided he had gone far enough, and so stopped suddenly in the trail. The combined efforts of several men were entirely unavailing, so, after half an hour, the saddle was removed, and the animal was left to his own meditations. Three days later we passed that way again, and found our yak within a dozen feet of where we had left him. Plenty of signs showed us that he had not wandered farther than that in all the time he had been left alone, but now, having outgrown his sulks, it permitted us to saddle him once more and to take him

ON THE MUZART GLACIER IN THE THIAN SHAN MOUNTAINS
Though it is impossible to construct a permanent road over the constantly changing surface of such a glacier as this, much of the trade between Kashgaria, south of the Thian Shan, and Dzungaria, which lies to the north, must pass this way. A large annual toll of pack animals is taken by this glacier, and the trail is lined with skeletons of the unfortunate beasts

with us along the trail.

Now and then, on some steep and difficult trail, one's yak will suddenly decide to go no farther, which in itself would not be so bad were it not for a habit that they sometimes have of reversing their direction suddenly, and backing abruptly down hill. This may be partly humorous, or it may seem like a near approach to tragedy, especially if the edge of some high cliff is in one's immediate rear.

With all their failings, however, yaks make travel possible in districts where great elevations, steep slopes, and the lack of forage prevent the utilization of other animals. Native as these creatures are to Tibet and parts of the Himalaya, they are acclimated to rarefied air and great cold, and are raised in numbers by the natives of the Pamirs and some parts of Mongolia. Only in Tibet and the Pamirs, however, have I seen them in common use.

The only other important beast of burden in Central Asia, donkeys excepted, is the two-humped, or Bactrian, camel. These huge, ungainly beasts are, of course, related to the lighter African dromedaries, but the differences between them are as great as are those between yaks and cattle. The African dromedary is not an animal noted for his good nature, but he is considerably outdone by his Asiatic cousin, whose disposition causes him to scream and groan at the slightest provocation, to kick and bite with very little cause indeed, and to show such a fearsome set of teeth upon being approached, as might make the bravest quail. It is not generally understood that an Asiatic camel can display a tremendous pair of canine teeth that would do credit to a full-grown lion, and though the camel drivers appear to pay little attention to the baring of these fangs, I have been told that the bite of a camel may easily prove to be serious because of the likelihood of blood poisoning.

The Bactrian camel is a cold-weather

animal, and travels best at low temperatures. During our travel by camel caravan in Dzungaria and Mongolia, it was noticeable that the speed of these animals was greater after the chill of night had fallen. During most of this journey the temperature was never above freezing, but the camels traveled best when it was near zero. During the winter they are protected by an amazingly thick coat of hair which forms an efficient armor against the snow and cold.

Mongolian camel-drivers commonly load these beasts with four or five hundred pounds of freight, and under such loads the camels of a caravan are likely to average from two to two and a half miles an hour. Twenty-five miles is an exceptionally long day's march, but no other animal could possibly perform the work a camel is called upon to do, under the conditions he is often forced to face. On muddy or icy trails camels are at a decided disadvantage, it is true, for their padded feet can obtain little traction, and their long legs, when they slip, often shoot out in the most surprising manner. On dry ground, however, this difficulty is overcome, and the camel is admirably adapted for travel in much of the desert areas of Central Asia.

Perhaps the most striking recollection that I have of Central Asiatic travel is of the night marches of our camel caravan. I can close my eyes and see the dim shapes of our thirty camels looming huge and weird against the background of snow that lay gray in the faint starlight. I can hear the camel bells clanging and booming in the darkness, their irregular sounds punctuated, now and then, by the shouts of the caravan men—shouts that end eerily in high falsetto notes.

KALMUCK HUNTERS OF THE THIAN SHAN MOUNTED ON BULLOCKS

Though the Kalmucks raise horses, they often ride bullocks when they are on hunting trips. What appears as a fork on the back of the figure at the right is really a ponderous muzzle-loader with a forked rest that is hinged to the barrel near the muzzle. This rest is an invariable addition to practically all native guns

AN ARABA

(*Above.*) The wheel horse maintains the balance of the load and steers it. The rope traces of the leading horses pass through large rings on the shafts and are attached beneath the cart

A TELEGA

(*Right.*) These light carts, the gauge of which is about three feet, are used for rapid transport in Dzungaria

A CENTRAL ASIAN TRAVOIS

(*Below.*) Similar, except for its upright frame, to the travois of the American Plains Indians, this conveyance is occasionally used in the Thian Shan

A TROIKA

(*Above.*) The Morden-Clark Expedition covered 250 miles in eight days by means of this three-horsed Russian vehicle

A BULLOCK CART

(*Left.*) Many of these crude vehicles are used in Dzungaria for the transport of salt and grain

THE AXLE OF A MAPA

(*Below.*) This cart is similar in construction to the araba but is lighter and, therefore, faster. The gauge of both these vehicles is about eight feet, but due to the fact that the wear on the wooden axles must be taken up by cutting new slots for the pin that holds the wheel on, the gauge of no two vehicles is the same

A BRIDGE IN THE THIAN SHAN
These flimsy structures must be crossed carefully, for any great concentration of weight or any considerable vibration is liable to cause their collapse

There was a strange and overpowering monotony of motion and of sound that made it almost impossible for one to stay awake in one's saddle, and many times I have straightened up only to find that sleep had almost overcome me. The camel men, long accustomed to such travel, usually draped themselves over the diminutive forms of their patient little donkeys, and frankly went to sleep, while Clark and I tried to keep the trail, or failing that, attempted to steer a course by the stars or by our compasses.

It must not be supposed, of course, that pack animals are the only means of transportation in Central Asia. It is true that none of this vast district is traversed by any modern conveyance, but in the less mountainous regions of Kashgaria, Dzungaria, Northern Mongolia, and Siberia, carts of various kinds are widely used. Two-wheeled carts are probably the most common, and in Kashgaria these take the form of the huge, unwieldy *arabas*, although the lighter *mapas* are used in the same district for more rapid travel.

The simplest of all these vehicles are the bullock carts so commonly used for the transportation of bulk freight in Dzungaria. One of these consists of nothing more than two wheels connected by an axle which revolves with the wheels. Upon the axle the body of the cart rests, being held in place merely by a couple of simple pegs on each side, between which the axle revolves. A single bullock is generally the motive power, and the driver usually sits on one of the shafts. In the case of a train of such carts, one driver is sometimes in charge of several of the creaking, groaning, heavily laden affairs. The wheels are of the crudest possible construction, as, of course, is everything else about the vehicle.

By comparison with these carts, the

arabas, which are very widely used, are really quite refined. They are two-wheeled also, but their wheels are mounted on journals, and rotate about the axles, upon which the bodies of the carts are firmly set. The wheels are not the crudely constructed affairs of the ox-carts, but are usually well made, being built up of spokes and felloes almost exactly as are the wheels of wagons used in America. The wheels are, however, very high, often measuring as many as six feet in diameter, and the gauge of these vehicles is, to an occidental, very wide indeed, being about eight feet.

A wheel horse is placed between the shafts of these carts, and is generally flanked by two other horses, outside the shafts. Occasionally one or two horses are harnessed ahead in tandem, although no very definite system seems to be adhered to.

Related to these huge carts are the smaller *mapas* which, with smaller wheels and lighter construction, are called upon for faster travel. Speed, however, in the modern meaning of the word, is not to be thought of in connection with any of the vehicles of Central Asia. If the going is good, and the horses are in the best of condition, lightly loaded *mapas* can sometimes cover as many as thirty miles in a day. The average day's travel with such a cart, however, is less, and an *araba* could never be made to lumber along at any such breath-taking rate.

If one is bent on speed, one must wait until he arrives in Dzungaria, where he can obtain a *telega*. These are four-wheeled conveyances, with a gauge of about three feet, and are drawn by three horses hitched abreast. They are very lightly constructed, and one is apt to imagine, from a cursory examination,

A FERRY ON THE AKSU RIVER

Two mapas, eight horses, and about forty men with their equipment, can be crowded aboard such a scow, which is pushed off into the current and, with the assistance of two planks at one end and a sweep at the other, eventually reaches the opposite shore about half a mile downstream

that they will fall apart at the very first bump. Thongs, pieces of wire, frayed rope, and an amazing variety of other connections are all that can be depended upon to hold these vehicles together. Yet despite appearances, they are surprisingly sturdy, and to my amazement those that we obtained made the 156 miles from Urumchi to Kuchengtze in exactly three days without a change of horses—an amazing feat for any Central Asiatic means of communication.

There are, of course, other methods of travel in that vast district that makes up most of the interior of Asia, but these I have named are, without doubt, the most important—unless one adds the sleighs, so commonly used in Siberia during the winter. With such primitive means of transport, it is only natural that Central Asia should remain what it is—one of the most backward of all the large divisions of the earth. Nor is it possible for a district so poor to build the roads necessary for an improvement of the situation. The richest of nations would hesitate to expend the sums necessary to build roads in so difficult a land. The time undoubtedly will come, of course, when better means of communication will be available. Already a very few motor cars have found their way across deserts and mountains to the interior of this land, but so few are they, and so worn by the vicissitudes of the long journey, that they are not to be taken seriously. Roads can hardly be said to exist. Paving is unknown, and it is possible that airplane travel may be practical before motor cars can make a very great deal of headway. Such exceptional journeys by motor car as those made by the Central Asiatic Expeditions under Roy Chapman Andrews are proof that the difficulties of the land can be overcome, but only by the most careful preparations are such journeys made possible.

BURDEN BEARERS IN ASIA AS ELSEWHERE

Donkeys are widely used in Kashgaria and the Thian Shan. They even accompany camel caravans across the Gobi Desert, although there they are ridden by the camel men

Central Asia is a distant land, difficult

A TRADING CARAVAN IN THE YULDUZ VALLEY

The camel of Central Asia is the Bactrian—a two-humped animal. It is a cold-weather beast, and travels best when the thermometer is below freezing. Burdens from 400 to 600 hundred pounds are usual

THE MORDEN-CLARK EXPEDITION LEAVING KUCHENGTZE

Thirty camels carried the equipment of the American Museum party about 600 miles to Kobdo, in Mongolia. It was while traveling with these animals that Mr. Morden and Mr. Clark were captured and tortured by Mongol soldiers of the Altai Mountains

CROSSING THE MINTAKA PASS

Yaks are widely used as riding and pack animals. Their hair makes excellent felt coverings for the movable dwellings of the natives, and the milk from the yaks is an important item of food. They are invaluable in a country where horses cannot be used because of the extreme altitude and the almost total lack of forage for much of the year

of entry. Little known and not widely traveled, it offers a fertile field in which the scientist can study widely, but until the modern world has made some impress upon it—until transportation in the modern sense has been introduced—all that vast district of mountains, deserts, and fertile valleys is likely to remain the distant, difficult land that it has always been—the land of mystery in which the world as it existed a thousand years ago is with us still.

SYMMETRY IN NATURE

Perfection of Design as Shown in the Mineral, Vegetable, and Animal Worlds

By HERBERT P. WHITLOCK

Curator of Mineralogy, American Museum

With Thirteen Figures by the Author

IT is one of the outstanding features of our modern life that we know many things without being conscious that we know them. We subconsciously observe facts and phenomena without realizing their significance, and we marvel at and admire that which excites our wonder and our admiration without stopping to orient our experiences or to analyze our impressions. This general impression of satisfaction which we receive from the perfection of form in the natural objects about us, makes us overlook how much this perfection of form is due to repetition of design. To cite a very familiar example: We are pleasurably impressed with the pattern of a certain design in wall paper, so much so, in fact, that we may have it put on the walls of our bedroom. However, it is not until under stress of a day of sickness or a morning of wakefulness we spend hours gazing at the wall, that we discover how many times and in what respects the pattern repeats itself.

Photograph by Clyde Fisher

PASTURE ROSE

The five petals of this blossom show five-fold repetition, or five-fold symmetry

This repetition is the basis of what is known as symmetry; as popularly conceived it may be expressed as the similarity of parts on opposite sides of a dividing line. A maple leaf is a good example of such symmetry with respect to a line, or, considering something with a solid rather than flat dimension, the outside aspect of our bodies may be used as an illustration. But in this case the line corresponding to the one that symmetrically divides the maple leaf must now be considered as a plane. The symmetry that repeats parts and members on opposite sides (to the right and left) of an imaginary plane dividing the object through the middle, is so universal among the higher forms of animals that it has become our standard for harmony and balance.

But the regular repetition of parts, which is symmetry in its broader sense, takes on a much wider aspect when we turn to the consideration of the lower forms of animals, and especially when we come to examine the plants. Everyone who has spent any time on a seabeach at low tide knows the different varieties of starfish with their five arms radiating from a center, or the sea urchins whose thin, spiny shells show designs repeated five times like the symmetry of a star from the blue field of our flag. Now when we examine these objects—the starfish, the sea urchin, and the five-pointed star—

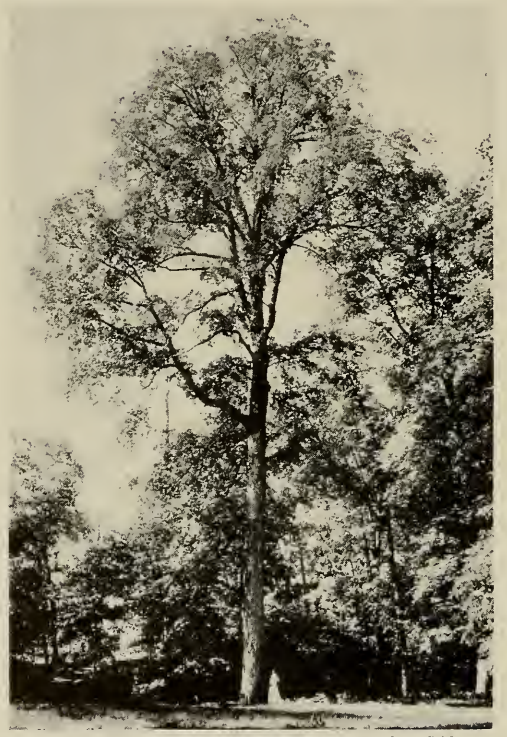
with regard to the repetition of their parts, we find that for each of them there is a central point about which it is possible to rotate the object until it appears in exactly the same aspect as in its original position, and that, on continuing the rotation through a complete circle back to the starting point, the object will appear, in all, five times in its original aspect. The central point (in solid objects, a central line or axis) about which we have revolved the object is a point of five-fold symmetry. Objects exhibiting five-fold symmetry —the symmetry of the starfish and the sea urchin—are extremely common in the organic world, although as we shall presently see, this kind of symmetry is entirely lacking in crystals, which constitute the overwhelming range of symmetrical objects in the inorganic realms of nature. To cite a few very familiar examples of five-fold symmetry: We have such common flowers as the apple blossom, buttercup, morning glory, mountain laurel, marsh pink, the single flowers of common milkweed and of phlox, and a host of others.

All of these have the symmetry of the five-pointed star at the top of page 163. That is, besides a five-fold repetition about the axis of five-fold symmetry (shaded in solid black) they are also symmetrical to the right and left of the lines marked I, II, III, IV, and V.

A maple leaf symmetrical to a line

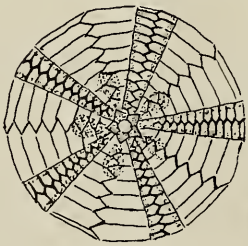
Now we can readily assume a pattern or an object which has a five-fold symmetry —one that appears five times in a certain aspect on revolving it through a circle, and yet cannot be halved into symmetrical right and left pieces like the five-pointed star. If we were to attempt to construct such a pattern, we might produce something like that at the bottom of page 163, which is just as much referable to a five-fold axes of symmetry as is the star, but lacks some of the elements of symmetry of the latter.

Having mastered what is meant by five-fold symmetry, let us look for other expressions of symmetry, based on numbers which are greater or less than five, but conforming to the same rule of repetition. The winged seeds of the sycamore maple give us an example of two-fold symmetry, because, holding them by the stems, we



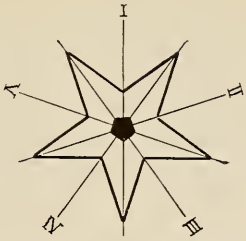
Photograph by Robert Ridgway

A SUGAR MAPLE
Each of the thousands of leaves of this tree shows the symmetry of the drawing above



The five-fold symmetry of a sea urchin

can twist them about until their original aspect is repeated in one complete twist. This is quite different from the symmetry of our bodies, which would necessarily have our heads repeated where our feet are, to fulfill the repetition requirement of this two-fold, or binary, symmetry.



Five-fold symmetry and also lines of symmetry

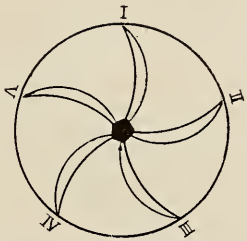
Similarly, we can find expressions of three-fold or trigonal symmetry in the very common three-leaved clover (not the unusual four-leaved one), and in such wood and marsh flowers as trillium or wake-robin, page 165, and in the blue flag or iris, page 166.

For an object of four-fold or quaternary symmetry, an open and empty chestnut burr suggests itself, although that beautifully conventional blossom, the dogwood, might be thought of here. We also have the six-fold symmetry of the wood lily and the dog berry. Then there are examples of symmetry in organic nature based on numbers higher than six, although these are relatively rare. When we consider examples of eight-fold and nine-fold symmetry, nearly always we find that these are only somewhat more complete four-fold and three-fold expressions respectively.

Photograph by E. M. Kittredge

DOGWOOD IN BLOOM

Every blossom on this little tree has four petals repeated in a beautiful design of four-fold symmetry



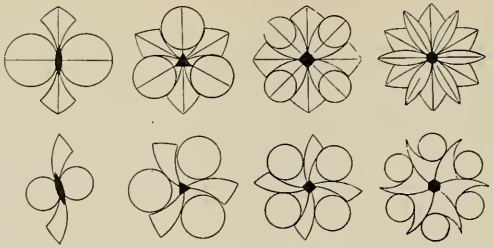
Five-fold symmetry but no lines of symmetry

In order to clarify our ideas respecting two-fold, three-fold, four-fold, and six-fold symmetry, let us study the group of geometric designs shown on page 164, which might be characterized as wall paper, linoleum, or fresco designs.

To verify the number of repetitions which determine the symmetry it is necessary only to rotate the page through one half, one third, one quarter, etc. turns to arrive at a repetition of the original aspect, in the instances of two-fold, three-fold, and four-fold symmetry respectively. The figures in the upper row are also symmetrical to two, three, four, and six lines of symmetry as indicated by the straight lines, but these lines of symmetry are entirely lacking in the corresponding figures in the lower row. In this way we have demonstrated the very important fact that symmetry, whether it be two-fold, three-fold, four-fold, or six-fold, does not necessarily include a line or lines of symmetry. Extending this principle to the symmetry of solid figures, *an axis of symmetry may or may not include one or more planes of symmetry.*

We have seen to what an extent the forms of plant life

illustrate symmetry in nature. It was through an appreciation of this perfection of orderly arrangement in plant forms that Réné Just Haüy was led to seek for and finally to find that ultimate perfection of symmetry, which in crystalization lies at the base of the great inorganic world. The Abbé Haüy, familiar as he was with the symmetries of plant forms, argued that such harmony of shape must also exist in the realm of inorganic nature. Now, between the symmetry of organic forms and that which characterizes crystals, there exists this comprehensive difference: In the shapes of the plants and of the lower animals, we meet with curved or rounded parts disposed in obviously symmetrical designs, whereas in crystals we find angular solids whose surfaces are composed of flat planes, and it is in the disposition of these planes with relation to one another that we must look for that symmetry of design which, although not always as obvious as that of a rose or a clover leaf, is far more satisfying to our reason because it is mathematically precise. In other words, it is a symmetry of angles, and of angles which are exact to the limits of our capacity for measuring them. Furthermore, in these solid angular forms we find the

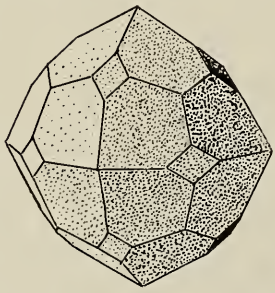


A group of conventional figures showing two-fold, three-fold, four-fold, and six-fold symmetry. The upper row is also symmetrical to the straight lines shown. The lower row has no *lines* of symmetry

Photograph by M. C. Dickerson

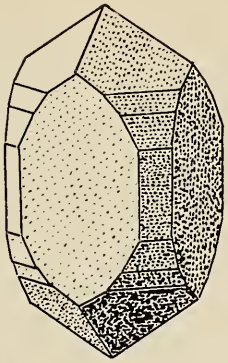
STAR FISH

Its five arms, exactly alike, show five-fold symmetry, the common symmetry of certain lower forms



A crystal of garnet drawn in perspective

highest expression of symmetry, that is, symmetry that is dependent on symmetry. Take, for example, a very common crystal, one that is quite characteristic of the mineral garnet and which is drawn in a sort of conventionalized perspective on page 164. If we were to handle this little angular solid, turning it this way and that, we would soon find that we could hold it in such a way that it would look like the first of the three drawings grouped at the bottom of page 165. Then reversing it and turning it to the right and left we would discover five more positions in which it presented the same aspect. But since these six positions are placed in three opposite pairs, it follows that we really have found three axes, and the disposition of the edges around them tells us they are axes of four-fold symmetry. Looking again at our garnet crystal, we find an axis of three-fold symmetry, as illustrated in the central drawing, and counting up the number of times this aspect of the crystal can be presented to our eye, we find that it has four such three-fold axes. And even now we have not reached the limit of complexity in the symmetry of this amazing little fragment of Mother Earth. It will still show us six axes of two-fold symmetry similar to that in the third drawing of the same series, not to mention nine planes of symmetry. Nor is this in any sense a unique example. There are hundreds of crystals of different designs (to use a popular term)

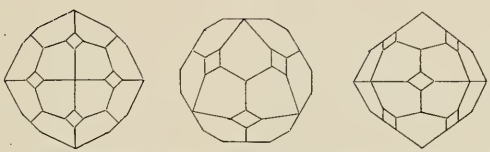


A crystal of zircon drawn in perspective

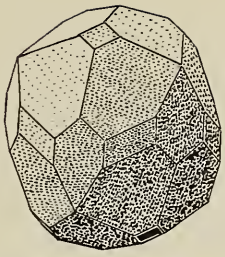
Photograph by Clyde Fisher

TRILLIUM IN FRUIT

Three-fold symmetry characterizes these triangular stars of the woods



A crystal of garnet viewed from various directions to show axes of four-fold, three-fold, and two-fold symmetry



A crystal of calcite drawn in perspective

scattered throughout the mineral kingdom, all of which are just as symmetrical as the one we have chosen.

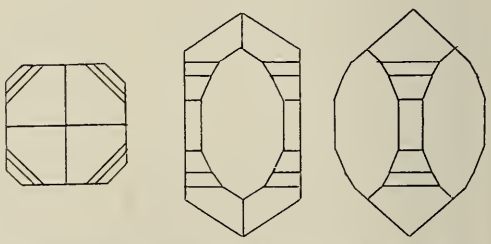
But let us turn to a crystal whose symmetry is expressed in a different way. The drawing at the top of page 165 is of a crystal of zircon, a silicate of zirconium. We see at once that this crystal is not nearly so perfect in symmetry as the garnet crystal of our last example, and consequently it is rather easier to analyze. Looking down on one end of it, or to speak technically, on its termination, we get the view shown in the first drawing of this series at the bottom of page 166, which shows us that the crystal has one axis of four-fold symmetry; the planes forming the opposite termination, which is the other end of the four-fold axis of symmetry, are grouped in exactly the same way as those shown in this drawing. Also, there are four views on different sides like the second drawing, meaning two axes of two-fold symmetry, and four more views like the third drawing, giving two additional two-fold axes of symmetry. As to planes of symmetry, we can divide our crystal into right and left halves longitudinally through each axis of two-fold symmetry, making four planes (looking again at the drawing at the top of page 165, makes this a little plainer), and of course we can also divide it symmetrically into an upper and a lower half, making one more plane of symmetry. So we have as the symmetry of this zircon crystal, one axis of four-fold symmetry, four axes of two-fold symmetry and five planes of symmetry one of which we call a principal plane and four of which we call secondary planes.

Photograph by E. M. Kittredge

IRIS BLOOMS

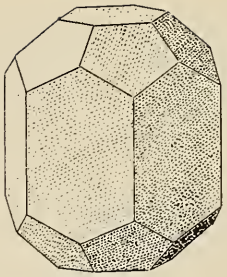
When the French conventionalized this flower in the *fleur-de-lis*, they emphasized its three-fold symmetry into a symbol

Now let us take another example, the crystal of calcite, a perspective drawing of which is shown at the top of this page. Searching this crystal for an axis of a higher grade of symmetry, we will profit by our study of the zircon crystal, and look down on one end of it, finding the view shown in the first of the pair of drawings on page 167. We have here an axis of three-fold symmetry, but one of a slightly different type from the axis of four-fold symmetry of the zircon crys-



Top and side views of the zircon crystal pictured on page 165, showing four- and two-fold symmetry

tal. It is true that the two ends of the axis terminate in the same combination of planes, disposed around the axis in the same way, but they are not as in the last example, directly one over the other; the edges of the upper termination are shown in full lines, and those of the lower in dotted lines. The effect is as though the one termination had been turned in reverse position to the other. It is also possible to find three axes of two-fold symmetry, giving six aspects of the crystal similar to the second of the two drawings at the bottom of page 167, and, as we are by this time prepared to expect, three planes of symmetry, each including the three-fold axis and one two-fold axis.

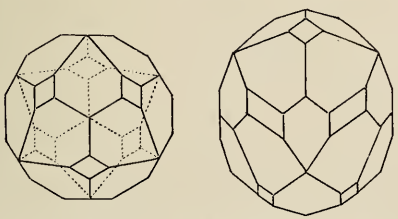


A crystal of beryl drawn in perspective

In the foregoing examples we have encountered planes of symmetry and axes of two-fold, three-fold, and four-fold symmetry. There is still another element of symmetry present among crystals that should be cited —an axis of six-fold symmetry. In the sketch at the top of this page is shown a perspective drawing of a crystal of beryl which has six-fold or hexagonal symmetry. It will be seen when we consider the three aspects of this crystal, shown in the three associated drawings on page 168, that here we have a combination of symmetry elements somewhat comparable to the zircon crystal of our second example. The difference is imposed by the axis of six-fold symmetry which in the first of the series of three drawings on page 168 takes the place of an axis of four-fold symmetry in the zircon crystal, and which necessitates six two-fold axes instead of four, and six longitudinal planes of symmetry as compared to four for the zircon crystal.

Photograph by E. M. Kittredge

A SPRAY OF MOUNTAIN LAUREL
This is one of the most perfect examples of five-fold symmetry among flowers

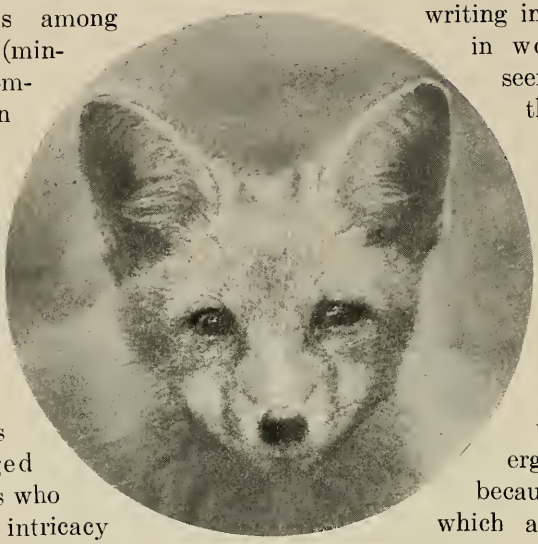


Top and side view of the calcite crystal pictured on page 166, showing three-fold and two-fold axes of symmetry

These examples, which have been chosen somewhat casually from among innumerable crystals, give us some faint conception of the orderly complexity of symmetry in this realm of nature. Early in the history of the science of crystallography there was deduced, on a purely mathematical basis, the possibility of the existence of thirty-two types or classes of crystal symmetry, involving the symmetry elements with which we have been

dealing. Up to the present time all of these theoretical classes of symmetry with one exception have been found to have representatives among natural compounds (minerals) or artificial compounds (produced in the laboratory) or among both.

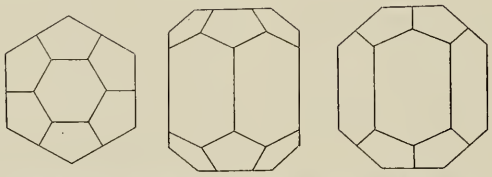
The recorded drawings of crystals of minerals alone amount to more than 26,000. It is not strange that, faced with this immense mass of orderly arranged matter, those of us who have explored their intricacy derive from the study of crystals a satisfaction that is probably to be found nowhere else in the manifestations of nature. There is a keen sense of harmony in the realization that a certain crystal face will be repeated at its proper angle and that one may expect to find it in its properly ordered place beyond peradventure. As Guilielmine, an Italian crystallographer, writing in 1705, has put it, in words which now seem to be little less than prophetic: "Crystallization is a curious and wonderful operation of Nature's geometry, and therefore worthy of being investigated with all the genius of man and with the whole energy of the mind, not because of the pleasure which always attends the knowledge of wonders, but because of its great usefulness in natural science; for Nature here, as it were, discloses herself, and having cast aside every veil, permits us to behold not merely the results of her operations, but the very processes themselves."



Photograph by Leland Griggs

HEAD OF A FOX CUB

Perfectly balanced bilateral symmetry is expressed in this animal head. This is the symmetry of the higher animals and of man



Top and side views of the beryl crystal shown in perspective on page 167, illustrating six-fold and two-fold axes of symmetry

SOME MISTAKES OF SCIENTISTS

Errors in Research Honestly Made and Honestly Corrected

RECORDED BY FREDERIC A. LUCAS
Honorary Director, American Museum

In their search for truth, scientists occasionally find that they have been led astray—that conclusions have been drawn that could not stand the light of later knowledge. That the true scientist is interested in exact knowledge is proved by the care he takes in calling attention to the errors that he finds. The correction of a mistake is merely another way of adding new facts to his field of research.—THE EDITORS.

JUDGING from an occasional reference in the daily papers, there are still people who believe that a palæontologist can restore an animal from a single bone. Unfortunately this flattering belief is not correct. It belongs in the category of things that our papers state as "interesting if true." Please note that the scientist has never made this claim for himself. The ability has been ascribed to him, so to speak, by popular vote, or by the statements of popular writers.

This belief seems to date back to the days of Cuvier, the author of the law of correlation, the relation of one part to another, and of the combination of the parts to habits; that horns would belong with hoofs, hoofs with complicated grinding teeth, and such teeth with a creature having a complex stomach and feeding on plants.

And to the days of Cuvier dates the story of the student who, to play a joke on the master, arrayed himself in a garb composed of lion and cow and confronted him in one of the dark corridors of the Jardin du Roi. The master eyed him with contempt and remarked, "Hoofs and horns, claws and canines. Evidently, Monsieur you are unaware that such a combination is impossible, *va t'en.*"

A little later this gift seems to have been bestowed upon Louis Agassiz with the variant that he could restore a fish from a single scale.

Now and then Nature seems to evolve, or to have evolved, some creature with the express purpose of puzzling scientists and of showing that there is no law (of anatomy) without an exception. One of these exceptions was found in the limb bones of a big beast from South America on which was bestowed the name of Toxodon. Huxley was fond of pointing out that here was a creature (its a pity that "an animal" sounds so bad, because its a phrase so often used) as big as a rhinoceros, about whose relationships and habits we knew nothing, where the "law of correlation" broke down. When more of its remains came to light, it was found necessary to make a new group or order to contain Toxodon and its relatives. How puzzling this animal was is apparent from the fact that at least one of our mammalogists considered that in spite of its size—as just noted, it was as big as a rhinoceros—it was the ancestor of our rabbits; which reminds one of Henry Guy Carleton's humorous remark that the tarpon couldn't be a herring, because no one had ever seen a tarpon as small as a herring or a herring as big as a tarpon, but this was before Mr. Beebe went to Haiti. Before this, a Spanish naturalist objected to placing big Megatherium with sloths and anteaters, because "all the other Edentates could dance in its carcass." If the reader wishes to become acquainted with Toxodon, he will find a reproduction of his skeleton next the group of ground sloths on the fourth floor of the American Museum, while above him one of Mr. Knight's reconstruction shows us how he probably looked.

IGUANODON
As restored in Hagenback's Zoological Garden
The first iguanadon fossil to be found was fragmentary, and the hornlike thumbs shown on the fore feet of this reconstruction were not in place. Because of the resemblance of these "horns" to those of the rhinoceros, the suggestion was made that they belonged on the reptile's nose. Later another fossil was discovered and the "thumbs" were placed where they belonged

But if Toxodon was a puzzle, the beast now called *Moropus* was still more so. In 1825 Cuvier decided that a peculiar toe bone submitted to him for identification was unmistakably that of a giant pangolin, one of the so-called scaly anteaters found in Africa and Asia. A little later (1833) teeth from the same formation as the toe bone were referred to the Ungulates, and toes and teeth were found together in several localities until M. Filhol ventured the assertion that, while these fossils had been assigned to two very distinct groups of animals, they probably belonged together, an assertion that proved to be correct. But if the farmer's remark about the camel, "there aint no such animal," was excusable, he would certainly have been justified in applying it to *Moropus*, which must have looked something like a camel with claws and was totally unlike any of our modern mammals.

The dinosaurs proved especially troublesome since they presented some features in their skeletons for which there were no terms of comparison. One of the earliest of them to be discovered was Iguanodon, a distant relative of our Trachodon, and among the first of the remains found were some sharp pointed bones not unlike small horns, so one was not unnaturally placed like the horn of a rhinoceros on the nose of the animal. Later it was found that this spine was really a thumb, and it was pointed out that to put his thumb to his nose was really an undignified gesture for so ancient an animal.

Another mistake, not by a palæontologist, but by an artist with more imagination than knowledge, was when Waterhouse Hawkins, in making his reconstructions, provided Iguanodon with five toes. Professor Owen pointed out that Iguanodon had only three toes, to which criticism Hawkins replied that if they were corns he would gladly

remove them, but as they were toes they must remain.

When Hawkins came to deal with Trachodon (*Hadrosaurus*) from New Jersey, he still further complicated matters by turning the slender pubic bones forward and making them epipubic or marsupial bones.

It is not surprising that mistakes have been made about fossil animals, since so many were, and are known by fragmentary remains, many of which belonged to animals without living representatives, for the palæontologist works backward, from the known to the unknown. Still, palæontologists are not alone in making mistakes, though they probably have more opportunities than other naturalists for so doing.

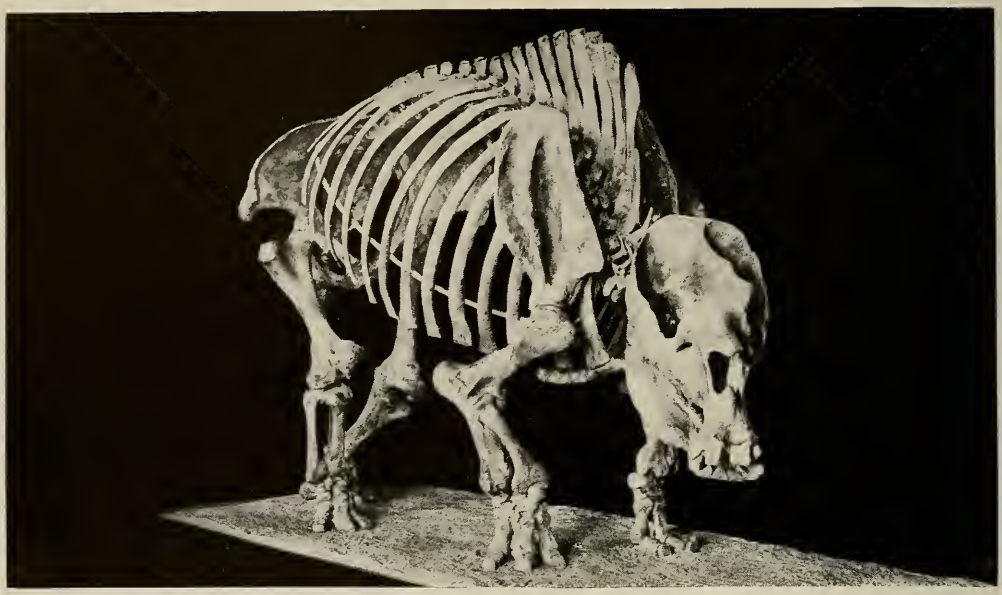
A curious specimen was brought to the British Museum from Japan, consisting of what seemed to be a short section of a rope of glass about which was a colony of polyps. While no silica-forming polyps were known, there appeared to be no reason why they should not exist, and this section was so described. But, later on, the glass rope proved to be the siliceous stem of a glass sponge and the polyps merely squatters thereon, who had built their colony around it.

Quite a different origin was assigned to the beautiful skeleton of the "glass sponge," known as Venus' Flower Basket, which was received with suspicion as possibly the handiwork of some skilled Chinese artificer.

A simple and amusing mistake that for all I know is still in circulation, was made in an early description of one of our gophers, or pouched rats. One of the first specimens of these queer little rodents to be discovered was a skin brought in by an Indian, with the pouches turned inside out, and it was so described and figured. If the reader chances upon one of the earlier references to this animal he will very likely find it depicted with pockets like little

THE ST. PETERSBURG MAMMOTH

This skeleton of the first complete mammoth found was, by some strange mistake, mounted with the tusks reversed as they are shown in this picture. For about a hundred and fifty years this arrangement was accepted as accurate, until Charles R. Knight questioned the outcurving tusks, and later finds demonstrated that the tusks should have been placed so that the ends would curve toward each other



TOXODON

With the finding of this fossil creature the "law of correlation" seemed to break down, and a new group had to be made for Toxodon and his relatives

bladders, one on either side of the head.

But worse errors than this have been perpetrated by some of our best authorities. One described an elasmosaur, a kind of extinct sea serpent, with its head placed upon its tail, a bit of transposition that he was never allowed to forget. However, this author of what a rival palæontologist said should have been named *Streptosaurus* (reversed reptile) was not without some consolation; from the west came a huge horn core that should have come from some great ruminant and on which was conferred the name of *Bison alticornis*. But some years later was discovered a skull with two horns attached. The skull was that of a dinosaur, *Triceratops*, that lived several million years before any bison had appeared on the face of the earth; truly dinosaurs have provided many pitfalls for palæontologists.

One of the strangest and most persistent mistakes in regard to an animal, one for which, apparently, there was little excuse, was made about the tusks of the mammoth and mastodon.

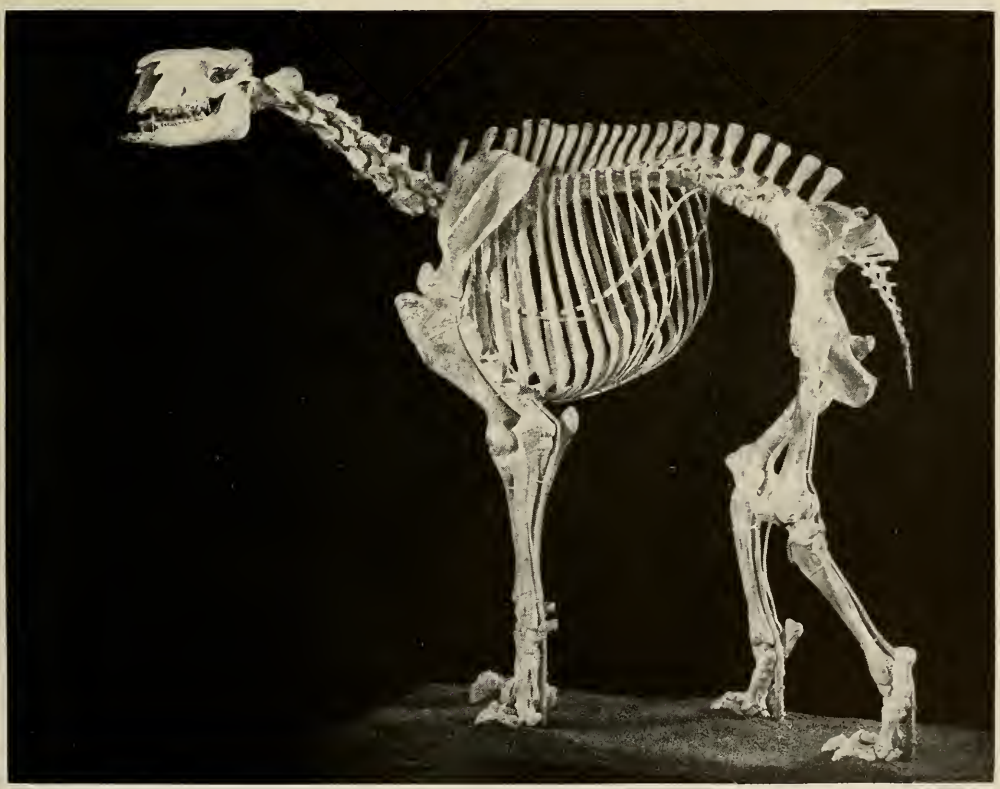
If anyone will look at pictures of the mammoth made before 1905, it will be found that, commencing with the Lena mammoth at St. Petersburg, the tusks are shown curving outward and backward, and a glance at a modern elephant will show that *his* tusks point forward and curve inward. How did the articulator of the St. Petersburg mammoth come to transpose the tusks, for that is what happened? Did he think that the mammoth ought to differ from modern elephants, and act accordingly?

At any rate, for more than a hundred and fifty years the mammoth was portrayed with these transposed tusks and I plead guilty to having helped perpetuate the error, for when I wrote *Animals of the Past*, both mammoth and mastodon were wrongly drawn.

So far as I am aware it was Mr. Charles R. Knight who first questioned the correctness of the accepted portraits of

the mammoth, and a careful examination of the few tusks then available showed that the trunk had rubbed them just as it rubs the tusks of elephants today, on the inner side. And then came the Indiana mammoth to clinch matters; this venerable beast had apparently lived a long and tranquil life, and had plenty to eat, so his tusks had grown accordingly, until they lapped by one another for about two feet. It was a physical impossibility for *his* tusks to have curved outward and backward, and so, after having passed current for more than a hundred and fifty years, the mistake was corrected and the tusks were properly portrayed.

Last, in this article, is the giant octopus. There washed up on the coast of Florida many moons ago a partly decomposed mass somewhat sacklike in shape, with a frayed-out fringe about it. It was well known that in the depths of the sea lurked giant squid, and as large octopuses had been found on our Pacific coast, there was reason to suppose that bigger still might be found. After due study of photographs and glowing accounts by non-scientific observers, the mass was named *Octopus giganteus.* However, some doubting Thomas put a piece of the animal into a big jar and sent it to the National Museum, where the jar was opened by a member of the staff, who promptly said "Blubber," a remark that was repeated by the friend to whom he showed it. And blubber it was, for it proved to be the



MOROPUS

This beast, which must have looked something like a camel with claws, upset several theories. Hoofs were thought to belong invariably with complicated grinding teeth but, while this creature had the grinding teeth, he had, instead of hoofs, an extraordinary set of claws

A GOPHER, OR CANADA RAT

As figured in Shaw's "General Zoology"

One of the first of these little rodents to be discovered was a skin brought in by an Indian, with the pouches turned inside out. Accepting the pouches as naturally belonging in that position, the gopher was so described and figured. The pouches should, of course, be tucked inside

wave-worn case of a sperm whale, from which the spermaceti had been taken before it was cast adrift. As an English writer observed, this shows the difficulty of sitting in Connecticut and describing a species in Florida. And now there can never be an *Octopus giganteus*, for by the rule, "once a synonym always a synonym" the name has been attached to the sperm whale and can never properly be applied to a cephalopod.

Apropos of octopus: many years ago Professor Morse pointed out that Victor Hugo in his *Toilers of the Sea*, made an amusing mistake. If anyone will take the trouble to read the lurid description of the devilfish, he will find some curious properties ascribed to the creature; to mention one, that of withdrawing its arms like inverting the fingers of a glove. Turning to a French encyclopedia, one finds that octopus is *poulpe* and the coral animal *polype*, just a difference of a letter, but that letter seems to have made all the difference in the world, and given rise to the glowing composite description by Victor Hugo. Rest assured that it is not alone scientists who make mistakes.

Professor Cope once told the writer that a man is bound to make mistakes, and that consequently the more work a man performs the more mistakes will he make. But let him be judged by his work as a whole and not by his errors; for each of the mistakes herein recorded, the author thereof made many valuable contributions to knowledge, and by these will he be remembered.

Humanum est errare

THE CAVES OF MT. ELGON

A Series of African Caverns Inhabited by Natives Who Still Are in a Stone Age of Their Own

By JAMES L. CLARK

Assistant Director, American Museum

IT was late one afternoon a number of years ago when our long line of tired porters, with ourselves in the lead, stopped at an isolated log-and-mud hut on the rolling, grassy plains of East Africa. We were tired enough to be sure that we had traveled more than far enough to have reached our destination at Sergoi, but still the village we had been expecting to reach was not in sight. The west had begun to color as the sun was sinking behind the only prominence on the distant horizon and, as the glare of the light softened, we could see the prominence take a definite form, a purple silhouette against a liquid, golden sky. It was a lone mountain with its convex sides sloping upward from a broad base, forming a truncated cone. Surely, we thought, this must be the extinct volcano of Elgon.

Sergoi showed on the map as a good-sized dot. We thought from that that the place was one of some importance, but we had come upon nothing save this single shelter, and it seemed that the village must still be afar off.

The chatter of our boys drew a somewhat seedy white man to the doorway.

"How far is Sergoi, sir?" we inquired.

"Not far, you're at Sergoi now," he replied.

We looked around to see if we had missed the village, but could see nothing but plains in every direction, except where a small bush-covered hill rose not far back of the hut.

"We thought Sergoi was an important place with a District Commissioner," my companion exclaimed.

"So it is," agreed the man. "The boma is just on top the hill there, in those little trees."

Although we looked hard we could see no sign of a house, nor could we make out enough room on the top of the little hill to hold a house suitable for a District Commissioner.

"If we go up and see the Commissioner," I suggested, "maybe he can help us out."

But the man replied that the Commissioner was away on some native business and only his servants were at home. As we seemed somewhat perplexed he invited us to stop a while. We entered his home to find it a sort of store, stocked with canned goods, clothes, and a few other articles that both white men and natives might buy. While he made us some tea we chatted, and we learned that he had lived where we had found him for about twenty years.

For some reason this abstract township was well known, and it took on more importance than one might think. Very few white men traveled that way, but wandering natives often passed en route to other districts because, perhaps, the tiny hill is the one point of significance in the whole surrounding country and becomes a veritable beacon that serves as a milestone on the veldt.

"Where are you fellers going?" the store-keeper inquired after a while.

We told him of our plans—that we were headed for Mt. Elgon, but first were to meet Colonel Roosevelt and his safari and collect some elephants. Carl Akeley, who headed our party, did the explaining. He and Colonel Roosevelt had planned

BUILDING A TEMPORARY BRIDGE

Among the higher foothills of Mt. Elgon there are occasional swift streams that are far too deep and swift to wade. Across these mountain torrents crude bridges were built by Mr. Clark's party in order that their belongings could be transported with less risk of a wetting

before leaving America to meet in Africa and hunt elephants together, and Akeley was to take the skins for the big group that was eventually to form the centerpiece of the African Hall in the American Museum.

The storekeeper told us that the Colonel had gone by some time before and was hunting somewhere between this point and Mt. Elgon, so we were keen in our anticipation of the meeting.

As we watched the sun disappear behind this mysterious mountain, it seemed to fascinate us, and we talked of the possibilities of going nearer it. The more we inquired of this man who had lived almost in its shadow for a score of years, the more we wanted to explore it. Hardly a handful of men had ever been to its base, and very little was known of it. The storekeeper had never been there and knew of no one who had. He warned us not to attempt it, saying the natives living in its forests were very bad indeed and would shoot us with poisoned arrows without ever giving us a chance to see them.

We made camp near the store and stayed for the night. The morning found us marching early, headed west with Elgon as our landmark. For two days we traveled, hunting a bit here and there, finally making contact with Colonel Roosevelt and securing rather unexpectedly the elephants that were so keenly desired. With the skins properly cared for, and the Colonel again on his way, we turned our thoughts again toward Elgon, for now we were almost at its base.

Supplies were low, but we believed we might secure native flour and rice enough to carry ourselves and our men through the rest of the journey. So we headed directly for the base of the mountain, where we expected to find a tribe called

KITOSH GUIDES AT THE ENTRANCE TO ONE OF THE ELGON CAVES

These "boys" had been assigned to Mr. Clark's party by their chief, but only after prolonged negotiations. It is probable that the spears carried by these men were manufactured by the Masai or the Nandi, and that the Kitosh had obtained them by barter

MR. CLARK'S SAFARI RESTING AMONG THE FOOTHILLS OF MT. ELGON
There were from sixty to seventy porters in this safari, in addition to an ox-cart that carried the bulky goods. Every half hour or so the party dropped its bundles for a rest, for the altitude and the heavy loads precluded longer marches between stops

the Kavarondo. From what we had been able to learn, these people were not unfriendly and, to help matters, we had secured from the storekeeper at Sergoi a quantity of trade articles, such as beads, blankets, and iron wire, to win their favor.

As we neared the mountain we found no villages, only a few well-worn trails that appeared to be those of game. The whole country was crisscrossed with comparatively fresh elephant trails where herds had trampled the grass or broken down branches as they passed.

It was here that I saw my first "honey bird" and its strange actions—an interesting little black and white fellow about the size of an English sparrow, that through some instinct has learned to associate itself with man to get its coveted feast of wild honey. My attention was drawn to an incessant chirping over my head and, looking about, I saw this little fellow darting ahead of me into trees beyond. I realized then that the racket had been going on for some time before I heeded it. Somehow he had learned the location of a wild bees' nest. On such an occasion when man, either native or white, comes within sight, the honey bird goes after him, attracting his attention by its noise, while it darts ahead in the direction of the nest. If the hunter heeds and follows, this little bird will lead on, but if not, it gets all excited until the man starts going in the right direction again. When the hunter finally comes near the treasure-laden tree, the bird quiets down and sits on a near-by branch.

If you are honey-bird wise, you will look around for a big hollow tree that might be shielding a wealth of golden nectar. Then, with a bundle of half-dried grass lighted as a smudge, you climb for the raid. What you spill is sufficient for the honey bird's reward and all are happy except the bees.

In this same way this clever little fellow coöperates with the honey badger, which raids and pays by the leavings.

Whether to turn north or south in this land of game trails we did not know, but luckily we chose the right direction when we took the southern trail, and after another two days came to a herder who led us to his village. Here we were met with much curiosity, but not in an unfriendly manner; in order to make sure of our standing, however, we camped and did everything we could to establish ourselves definitely with the natives. They were not the Kavarondo we had expected to meet, but a tribe called the Kitosh.

We thought that a day would obtain for us the desired food and friendship, but they seemed in no hurry, and we could not force matters. Each day the old chiefs would come "in state" and pay us a long visit, while we wasted valuable time trying to be nice to them as we bartered for our supplies and for men to guide us. Whether or not they had ever seen white men before, we never definitely learned, but their curiosity was aroused at everything they saw in our equipment. Our safari must have been to them as a circus is to small boys, for they kept us waiting for three days before the supplies and men were in our hands.

At last, saying "good-bye," we followed the five spearmen we had obtained, along the base of Mt. Elgon, and then started our long, gradual ascent. Around the base of the mountain there was rolling country, open scrub with occasional large trees. For the most part, although now we were at an elevation of about 6000 feet, it was rather arid. As we climbed, heading northward on to the very base of the mountain, we began to enter forests that became more dense.

At the end of the first day we had climbed well up the side, and we made camp in a glade. We had some anxiety

PEOPLE OF THE CAVES

Though these people slightly resemble the higher type Masai, there seems to be no close relationship. They live in or near the caves of Mt. Elgon, and have their "shambas" or small gardens close by. Their small herds of cattle and sheep are driven within the cave entrances each night

THE FIRST CAVE VISITED BY THE CLARK PARTY

The people who lived in this cave ran away upon hearing the approaching party. Later a few of them returned and admitted that they had believed the newcomers were a raiding band of neighboring savages

as to the natives, although we believed we were still in the land of the friendly Kitosh.

The next morning we had not gone far before we came to a "rim rock" that occasionally showed itself projecting above the forest. This could be traced for some distance along the mountain-side. It was among this formation that we found the remarkable caves for which we were looking, and of which Rider Haggard made so much when he wrote the weird story of *She*. Our guides led us to a group of these caverns and we spent the rest of the day exploring them.

The rock projected as a shelf from the rather steep slopes and occasionally there was a natural cave which ran horizontally into the ground for unknown distances. They were evidently formed by erosion and in some of them the natives had established homes. Who these people were we could not learn. We saw none of them, for they had decamped when they saw us coming. That they are different from those who guided us from below was apparent from many signs, and when we asked our guides who these cave dwellers were, the only answer was "Shenzi"—wild people. This, however, meant very little indeed, as all African tribes consider any other people but themselves "wild people," each tribe being in its own estimation the one superior race.

The abodes in the caves were very primitive. There in the dark caverns one went back fifty or a hundred thousand years and found himself at the very fireside of the cave man. Elephants were about us in the forest, and rhinoceroses were roaming the rolling plains hardly a stone's throw below. Certainly we were in the heart of a primitive land. Here was man, still in the savage state, with stone and wooden implements of the crudest workmanship; with little stools made of split logs, flat side up, the branches cut off to form the legs.

A few simple, wrought-iron axes, smelted from the surface iron and pounded

crudely into shape, were in evidence, for they had advanced so far as to make tools to till small patches of ground. Granaries, simple and crude, woven of brush, stood on stilts sheltered just within the entrance to one of the caves, while at the other side, where the roof sloped back, a section had been barricaded with heavy sticks set in the thin layer of soil and interwoven with others to form a one-room house—drafty, open, crude—hardly more than a bird would make and certainly much less ingenious than the home of many of the common birds.

Not a thing could be seen to indicate that a civilization existed on their globe. They did have a few cattle and sheep, which they sheltered within the cave at night and protected from leopards by a fire at the entrance.

We passed on back into the caves, but found no end, and dared not go beyond the light of day lest we should be forever lost in a hopeless labyrinth that might be ready to entrap us. In the darkened chambers hundreds of bats as big as rats whirred about our heads with a roar of disturbed air like the sound of an approaching storm. Emerald beads in pairs gleamed at us by thousands wherever a ray of light from narrow passages refracted on the eyes of the creatures as they clung in solid masses to the walls.

No native had ever dared to enter these depths, and perhaps they had never been explored. The minute droppings of the untold thousands of bats had fallen and covered the floor with a layer like snow, smooth and even, inches deep in most places and a foot in others, proving by its undisturbed surface that this sanctuary had not been entered by man or beast. If it had, the tracks would have remained uneradicated for a generation.

When we came out, we found that some of the frightened cave dwellers had re-

A VIEW FROM WITHIN THE FIRST CAVE
Inside the cave stood a few simple structures. The two shown in this picture are wicker granaries set on stilts in order to protect the contents from moisture

turned—a mother and her tiny, shiny black tots. No men were about. They, no doubt, never expected that their retreats would be visited. They may never have been. We believed these fellows were out hunting or herding their stock in some of the open, grassy glades.

Sitting about the fireplace at the entrance to the cave, we commanded a most magnificient view of a great sweep of country below—a vista that rolled off for miles to the horizon. Time passed all too quickly on this first visit and we had to move on again, winding up glades, through forests, ever going upward. Our boys had told us of other caves farther up the mountains—but they seemed to have a fear of them and spoke of them with much superstition.

The following day we were on our way again, now through a jungle almost tropical—immense trees and vines, with moist ground beneath and with here and there a grassy dell where the sun came shining through. Toward the end of the day our guides told us that we would soon be near the mysterious caves and we pushed on, doing our best to have a chance to visit them before dark.

It was late in the afternoon when our guides halted and told us we must now go through the forest from this point if we wanted to see these other caverns, so, leaving our safari, and telling them to go on and make camp at the first good spot on the trail, we made our way along the slope. The trails were indefinite and often petered out—hardly more than game trails. Finally our boys stopped. We had come into an open glade and were standing on the edge of a ravine which dropped abruptly for thirty feet or so. The sides were covered with scrub, and we heard the sound of water below us but could see none. Upstream a short way we could see the end of this ravine,

THE CAVE OF THE WATERFALL

The entrance to this cave is through the small opening shown at the left. It is necessary to leap into the darkness beneath the fall, which barely shows above the bush in the center of the picture

A VIEW FROM WITHIN THE CAVE OF THE WATERFALL
The little waterfall shows plainly here, as well as the path that leads into the cave. When the Clark party entered, they found that the cave had been deserted some time before by its inhabitants, for the crude huts were partly fallen down

where the bush was more luxuriant. A tangled growth seemed to bank the end, while over this blanket of green spread a lovely waterfall. There were some dark spots in the green, and as we came closer, we saw that they were holes. The guides told us that this was one of the many caves and that this one was known as the "cave of the waterfall."

It seemed a difficult one to enter, and they told us that the only way into it was along the other side of the ravine and finally in under the falls to the large hole that the falling water partly covered. As this seemed quite impossible without our getting a good wetting, we decided to go to our camp for the night and return in the morning in order to do our exploring when the light was better.

As we marched along the trail, following our boys' footprints, we wondered how far they had gone, as in this forest there seemed little chance of a camping spot. It was but a few minutes, however, before we began to see clumps of bamboo, and shortly the transition was complete. We had left the forest behind and now were surrounded by tall swaying bamboos. A chattering ahead told us we were nearing camp and presently we saw blue smoke —a decided blue accentuated against the dark green of a bamboo forest wall.

There was camp, in a beautiful grassy spot just large enough to hold the circle of tents, with a blazing fire looking cheery in the cool forest twilight.

We knew by the presence of bamboo that we had reached an elevation of close to 7000 feet, and after supper we did not linger long, but crawled into our blankets to get away from the chill night air. We were called at daylight, and the usual cup of hot tea, which was brought by our tent boys, gave us warmth and courage to leave our snug beds.

It was a weird but a fascinating camp, in a deep green hole, with tall, lace-topped bamboos fencing us all in. We could see nothing but the sky, and again watched the curling smoke of the camp

A CAVE DWELLING ON MT. ELGON

The wicker granaries are shown at the right and left, while a native hut is shown against the cave wall in the center of the picture. A simpler dwelling could hardly be built. Many types of birds' nests are more complicated and more comfortable

fire in the still morning air until the beams of golden sunlight touched the top of the bamboos and began to creep down the stalks. I shall never forget the beauty of the reflected golden light flooding our well of green. Africa is truly a wonderland, and a single morning like this is worth the trek of a year.

But we could not wait for the sun to warm us, so we started for our cave, knowing that by the time we got there the sun would be shining into it. We followed the guides down across the little ravine, and hugged the wall of the opposite bank until the very water of the falls sprayed us. We could not see then how we were to get into the cave. But finally, as we stood there, our guide made a dash, and then I saw him leap and disappear behind the screen of water. Shortly he called, and another followed. Then I decided to try it. It was a strange feeling to make a dash into the unknown behind that water, but I started, and when I was in mid air, clearing the pool below, I could see where next to go. As I alighted on a big rock I turned and came immediately behind the wall of water, almost touching it. From there I could see into the cave and, as the rest followed, we started our exploring trip.

The air was damp and cold, yet the ground of the cave was dry and powder-like. The entrance was small and narrow, like a foyer, but from that there opened a great chamber, probably fifty feet square, and with a high, domed ceiling. It took a little time to adjust our eyesight to the darkness but shortly we could see quite well, as the sun had now struck into the little ravine, throwing considerable reflected light through the small entrance. At the back of the cave we could see other black openings leading farther, but how far we could not tell. As we came near to these openings, we noticed that they

were caused by tremendous blocks, weighing hundreds of tons, that had fallen from the ceiling. The formation in this cave was dark brown conglomerate, which contained many scattered pieces of petrified wood, while the first cave we had visited was formed of a gray limestone. Some have said that these caves are forgotten mines, but this I doubt.

As our eyes became more accustomed to the dim light, and we could see farther into the darkened corners, to the left we noticed for the first time some huts. There were three or four, but only one or two remained in good condition. They were round, about ten or twelve feet in diameter, with straight sides about four feet high, and flat tops. A single small doorway was the only entrance to each one. The huts were constructed of bamboo sticks driven into the ground at distances of a foot or so. They were intertwined with the long flat bamboo "leaves" that come from the stalk. The roof was similarly made, and the whole structure was plastered with mud. In the center of each were the ashes of a fire. Otherwise there was nothing of significance.

These huts had not been used for some time. I looked about for remains of implements or telltale signs of those who might have inhabited them, but could find nothing. Our natives, neither guides nor porters, could tell us except to say "Shenzis" again, and we wondered if they were the wandering people of the bush who we had been told would shoot us with poisoned arrows.

Our little flashlight was weak and next to useless, but we worked our way over a great block and finally slid down the other side, now in total darkness except for our

ABANDONED HUTS OF THE CAVE OF THE WATERFALL

The rough conglomerate roof contained many bits of petrified wood, and two large bowlders that had dropped from the ceiling are shown behind the huts. The party penetrated far into this cave, and finally stopped at the brink of an abrupt drop below which lay a pool of water. So deep was the pit that the beam of the pocket flashlight carried by the party did not reach the surface of the water, though they knew that it was there by the sound of the splash when stones were tossed into the blackness

dim lamp and a faint ray of light over the top of the big block that told us where we had come from. We were in a small chamber, evidently a part of the big one before the block had fallen. Ahead we could see a small hole and, getting down on our hands and knees, we crawled through. It was uncanny and dangerous business and I didn't like it at all.

We found we could stand upright, and as we did we heard a weird sound, a sort of wail—the wail of a banshee. Swinging our little lamp about, we could see nothing but the ground immediately in front, rocky and rough. We called, and our voices echoed back as if in an immense chamber. Bats whirred about our light and our heads in hundreds, until we thought they would surely strike us. Cautiously we moved forward with the light on the ground, testing every step before we trusted our weight. Pools of crystal clear water lay here and there, but they were filled with dead bats in all stages of decomposition. As in the other cave, we were undoubtedly the first ever to enter here, as the bat droppings lay soft and very thick like dust on the floor and rocks, and our feet sank deep as if in snow. The mournful wail got on our nerves, and seemed to come from above, so we peered up into the inky darkness which our weak light failed to pierce.

Suddenly we saw a tiny ray of light, a mere dot like a star. We could not make it out. For some time we pondered over this, and then made it out to be a tiny hole through to daylight. As we watched, the wail continued, and we decided that it was nothing more than a current of air rushing in through the cave door and out through this little hole.

Satisfied with this, we continued a bit, ever cautiously, fearful that we might lose

ANOTHER DESERTED HUT

This delapidated hut was of a higher type than were those in the first cave to be visited, but the builders had long since departed, leaving the cave to the innumerable bats

IN THE CRATER OF MT. ELGON
The size of these giant groundsels can be visualized by searching for the man standing at their base in the center of the picture

the direction of our retreat. We came to a ledge and below and beyond on all sides was that inky blackness. Again we threw stones ahead to sound the ground, but did not hear them fall. Then a heavier one was cast, and it seemed seconds until a faint splash met our ears. Somewhere, way, way down, was water. That was enough. We were on the edge of nowhere and thought we had best go back.

We returned and cast our light about; the tiny green emeralds again flashed as they hung in clusters on the walls. This was our chance to secure some. We hesitated for some time, debating whether we should dare fire the shotgun. The tremendous concussion might loosen more of the ceiling that might be hanging only awaiting something much less than this to bring it down. But it was a chance to serve science and we decided to take it. We stood side by side while Akeley pulled the trigger. The terrific roar that followed set both the echoes and the bats to flying until the air seemed almost solid. We groped our way to the base of the wall where many had fallen, and selected those we wanted. There were three different kinds.

We were glad to return to the open air and to see the daylight again. But relieved though we were to leave the eerie cavern, we were glad to have explored it, and to have compared it, in our imaginations, with the cavern of Rider Haggard's "She-who-must-be-obeyed." But though the Caves of Mt. Elgon are almost as wild and weird as are the imaginary caves of *She*, the gentle black people who carried our kit could never for a moment be imagined as comparable to the fearful Amahaggar tribesmen that Haggard invented, nor were we the less pleased on that account, for any visit to the Caves of Mt. Elgon is likely to be adventurous enough for comfort, without the murderous activities of any such tribe as Haggard's impossible Africans.

Digging the trap

LITTLE "BEASTS OF PREY" OF THE INSECT WORLD

How the Ant-Lion Larva Builds Its Trap and Obtains Its Food

By FRANK E. LUTZ
Curator of Insect Life, American Museum

Doctor Lutz has for several years been making a study of the number of insects to be found in his own back yard near New York. He has discovered more than 500 species. These specimens are being placed an exhibition in the American Museum as proof of the abundance of nature-study material right at our very doors.—The Editors

WE have not, so far as I know, had larvæ of ant lions living in our yard, but there must be some not very far away, since an adult, looking like a pale, flimsy, night-flying dragon fly, was found at our porch light. Unlike dragon flies, adult ant lions hold their wings close to their bodies when at rest. Our soil is not loose enough to suit the larvæ and we have no overhanging shed-roof or anything of the sort to make a relatively dry spot on the ground. I am tempted to fix a place especially for them and, if necessary, import a few larvæ from the yard of some more fortunate person—but, of course, I would not count these among the five hundred insects that I have found in our suburban New York yard.

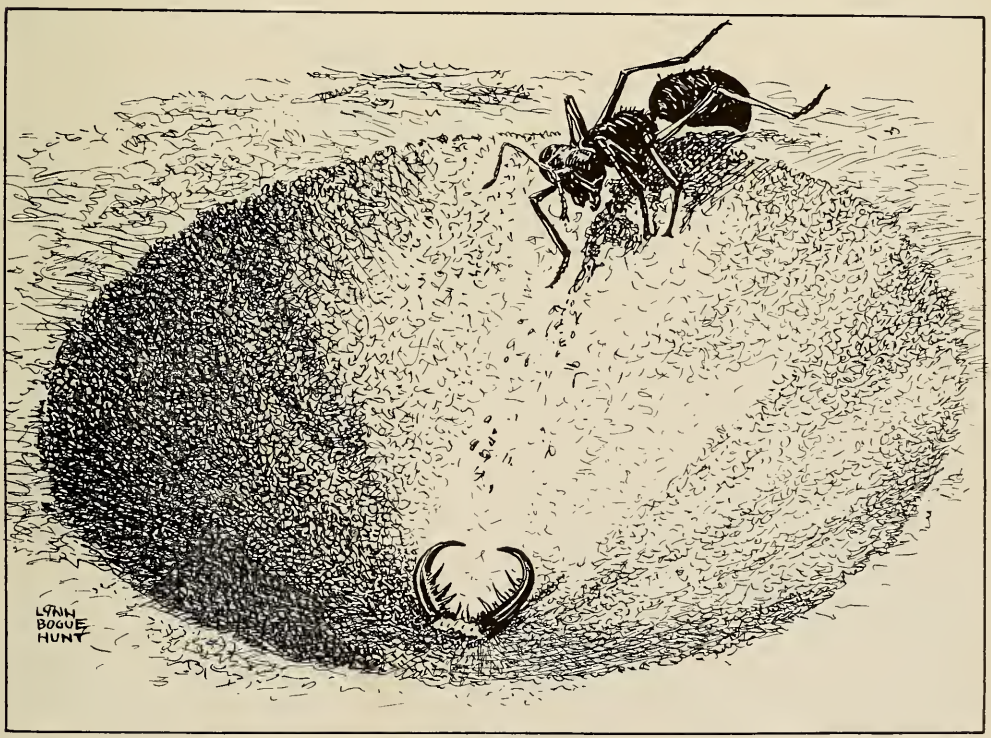
I once joined a party of tourists who were "doing" the old cliff-dwellers houses in the Mesa Verde National Park of southwestern Colorado. On that occasion the professional guide was barking his speech with the facility of long practice, when he was rudely interrupted by one of the party pointing to conical pits in the dust that formed the floor of the house, and asking if the roof leaked. The roof was the whole top of the cliff but the guide "reckoned maybe there was a drip." I happened to have a broad-bladed knife with me and, after thrusting it under the bottom of one of these pits, I raised it quickly and flipped out one of the homeliest-looking creatures an ordinary person would care to see. For a while the ancient cliff-dwellers were forgotten and some of the present-day tenants of the ruined dwellings held the center of the stage. The conical pits were traps made and tended by larvæ of ant lions, a thing four-footed lions do not do.

Mother Ant Lion lays an egg here and there on, or slightly in, loose earth, and after that it is entirely up to her offspring to take care of themselves. They live by

killing and eating other insects, and although they have large, sickle-shaped jaws, their legs are too short to travel the rough ground. They have never seen a trap made, have never seen even a completed trap, and yet they go about making a rather efficient one. You can easily watch the process by putting a larva on an inch or so of sand in a dish.

First, the larva pushes its way below the surface, flipping the earth up by jerking its head. Then it begins traveling just under the surface, flipping the dirt up as it goes. But, and here is the interesting point, it travels in a circle that is perfect—almost. Instead of being a perfect circle it is just enough short of one so that the path spirals toward the center. How the larva does it without being able to see anything or to touch a central point, I do not know. To me it is more marvelous than the spinning of a spider's web or the leaf-cutting of a Megachilid bee. As it works toward the center it goes deeper, continually flipping, until finally it has made a conical pit at the bottom of which it lies completely buried in the earth except for the sharp tips of its jaws, which project into the bottom of the cone.

Now for results. An ant or some equally small and equally inquisitive or careless insect comes along and steps on the edge of the pit. A few grains of dirt rattle down the sides, and flip goes the head of the larva, sending a whole shower of particles up to slide back into the pit, carrying the small, inquisitive, or careless insect with it. The sharp points of the waiting jaws do the rest. Could you improve on the plan? How did the ant-lion larva, that never saw such a pit and

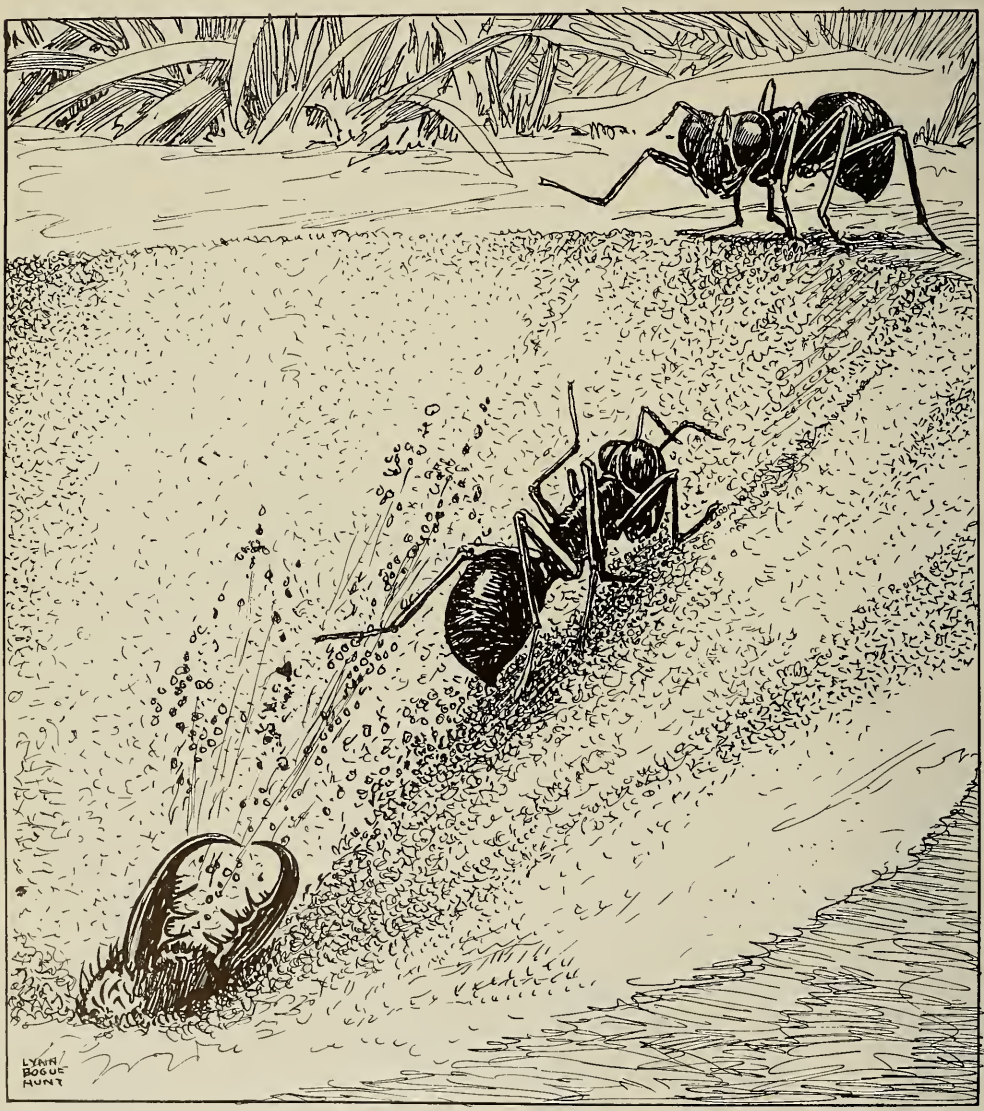


THE COMPLETED TRAP

A prospective victim is entering the trap. The trapper has buried itself at the bot om of the pit and calmly, but with jaws in readiness, awaits the next step

that never saw its parents, learn how to make and work the contraption to its advantage? When you find this out you will know something about the development and inheritance of instincts.

The rest of the story seems simple because it is more usual. When full-grown, the larva spins a cocoon under ground, pupates, and finally emerges as an adult that looks like a pale, flimsy, night-flying dragon fly whose wings, when at rest, fold close to the body. When it flies to a porch light, it does so "instinctively" but to its disadvantage, because that is usually its unprofitable end. So, before you know everything "about the development and inheritance of instincts" you must know about this, too.



THE TRAP IN ACTION

One unfortunate ant is trying to climb out of the pit, but the shower of sand, thrown by the twitching of the trapper's head, will doubtless roll the unwary one within reach of the trapper's jaws. The thoughts, if any, of the ant at the edge of the pit may be left to the imagination

From a Group in the American Museum

The scene is on the San Carlos River, Arizona. In the middle distance the construction of an Apache house is shown in progress. In the foreground is a flat-topped "shade" splendidly adapted to Arizona climate for summer living purposes

NATIVE DWELLINGS OF NORTH AMERICA

Some of the Numerous Structures Inhabited by Aboriginal Americans

By PLINY E. GODDARD
Curator of Ethnology, American Museum

TO the average person the tipi is, perhaps, the typical American Indian dwelling. This impression has been fostered to some extent by the "wild west" fiction of the last three quarters of a century, but as is the case with most such impressions, it is wide of the truth. The houses built by the natives of North America in pre-European times varied greatly in shape, size, and material. To some extent this variation was due to geographical and climatic conditions. Snow houses would hardly be durable in Arizona, even if the material for their construction could be secured there. Nor are houses of split planks to be expected in the treeless regions of the Arctic or of the great plains.

The type of habitation used by any people is conditioned chiefly by the sort of economic life they pursue. A hunting people may be compelled to follow the migrations of the game and therefore have either portable habitations or else simple ones which can be quickly built and abandoned without great loss. In America it frequently happens that several occupations are followed according to the season so that there are regular movements to streams or the ocean for fishing, or to the uplands and mountains for game or wild vegetable food.

The size of the dwellings in many instances depends upon the social customs and what is considered a family. There is a tendency in certain regions for the sons, when they marry, to remain with their children in the parental home. Among other tribes it may be the daughters who remain after marriage. In either case, the household consists of four or five biological families.

Courtesy of the Museum of the American Indian

A PUEBLO

In this village of San Ildefonso in the Rio Grande Valley, New Mexico, the houses are of only one story. This is probably due to European influence. In the background is Black Mesa, a prominent feature of the landscape and of great sentimental importance to the Indians of the region

HOPI INDIANS

The village of Walpi on the First Hopi Mesa in New Mexico is the best known of the Southwest pueblos. The snake dance held here biennially is attended by thousands. A family is shown busily engaged in domestic duties on the house roof in the American Museum group of which this is a photograph

Courtesy of the Museum of the American Indian

SAN JUAN PUEBLO

This portion of the village of San Juan in the Rio Grande Valley of New Mexico shows how the second stories of the houses are terraced back, so that the roofs of the first stories become the porches of the second. In ancient times the walls of the lower stories were unpierced and the rooms were entered by means of ladders

Courtesy of the Museum of the American Indian

A SUMMER HOUSE

The women and children of a Navaho family at the entrance to their summer house. These houses are temporary and take many forms. They are built to furnish shade and shelter from the prevailing winds

Photograph by Macmillan

SNOW HOUSES

The winter houses of the Eskimo are dome-shaped and built of blocks of hard snow held together by a keystone

The differences in houses, as in other phases of life, are chiefly traceable to habits and customs which have originated in the remote past. A son builds a house like that in which he was born because he is accustomed to that sort of a dwelling and he knows how to build only that kind. Stone suitable for building is found in many regions, but nowhere north of Mexico did the Indians know how to arrange it so as to roof over spaces. The first-growth pines of Maine would have yielded excellent building planks, but the Indians there lacked the knowledge and skill possessed by the Northwest Coast Indians for working wood.

If we begin at the North with the Eskimo, we have a people given to seasonal migration with two kinds of habitations. In summer they go to the interior to hunt caribou both for food and the skins from which their clothing is made. The caribou migrate both with the season and with the prevailing winds. During the summer the Eskimo live in skin-covered tents with such frames as can be made from the scanty timber of the district or from the bones of whales. In winter these people live close to the sea where they can fish and hunt sea mammals. As soon as snow accumulates and becomes hard packed, dome-shaped houses are built with blocks of snow. The builder stands inside and carries the blocks of snow around in an upward spiral, fitting them together with a large knife. The tops of the blocks are inclined toward the center in such a way as to form a hemisphere. At the top a block is fitted in, which acts as a keystone. Windows are sometimes made of clear ice set in the snow wall. Such houses are durable as long as the weather remains cold. They can be made practically air-tight by filling the cracks with snow. Heat is provided by a lamp which burns blubber and serves for cooking as well as heating. It is only in the Arctic that continuous cold for months makes such material feasible for house building. On the other hand, if the Indians of the Southwest had the skill and knowledge of the Eskimo, they might build permanent water-tight roofs of soft sandstone with arches or domes held in place by a keystone.

South of the Eskimo, in Canada east of

the Rocky Mountains and in the United States between the mountains and the Mississippi River, were hunting tribes who followed the game. They had conical dwellings consisting of poles slanting to an apex from a circular base. These poles were secured by tying at the meeting place above. They rested either on a tripod of similar poles or two pairs of poles tied together and erected first. The covering of these tents in pre-Columbian times was chiefly of skins dressed and sewed together. In the north the skins employed were those of the caribou which are very white when new. In the south the skins of buffalo cows were employed. The tipi standing in the Plains Indians Hall of the American Museum is made of the skins of domestic cattle, but there are in the Museum's collections two covers of buffalo skin.

In the New England states and eastern provinces of Canada, birch bark was sewed into wide strips and these were wrapped around a similar frame work of poles. This bark could be rolled up and transported in canoes or on sledges, and new poles cut almost anywhere. On the great plains suitable poles were secured with difficulty. They had to be sought in the mountains and carried long distances. When the camp was moved the poles were dragged to the new site. This was done in early times by dogs and later by horses.

The Iroquois Indians of New York State were and still are strongly agricultural. There is fair reason to suppose they came from the south and brought with them certain southern traits such as the use of the blow gun. They counted their descent through the mother and were grouped into clans. Their houses are known as "long houses," being in some cases 100 feet long. The width was moderate, being about 17 feet. A passageway ran straight through the middle with compartments on either side opening into it. There was a row of fires running through the center, so placed that four compartments were served by each fire. The people occupying such a house were related to the matron who controlled the house, either as married sons or married daughters. These houses had frames of

Photograph by Macmillan

REPAIRING THE WINDOW OF AN IGLOO

The Eskimo seem to have been the only American natives who possessed the skill and knowledge to build houses with arches or domes held in place by a keystone

poles and were covered with elm or oak bark. Such houses were common in the seventeenth century and a few were built late in the eighteenth century.

Pawnee on the Platte. The houses of these Indians are known as earth lodges, since the roofs are dirt covered. The main frame consists of four large posts set firmly

American Museum of Natural History

A MICMAC WIGWAM

Wherever birch bark was plentiful, the conical houses of the Algonkian Indians of New England and Canada were covered with the bark sewed to form long strips. The wigwam illustrated, which is now in the Eastern Woodland Hall of the American Museum, originally housed a Micmac family

The houses of the Virginia Indians were also long and narrow and were occupied by several families. We know them from the drawings made by John White in 1585 and from the description given by John Smith. The frame of the house was made of bent poles lashed together so that the roof was vaulted. The covering was composed of mats or bark.

Not all the tribes on the great plains lived exclusively by hunting. Certain tribes had villages along the Missouri and the Platte rivers where rather extensive corn fields were cultivated by the women. Among the best known are the Mandan, now nearly extinct, the Hidatsa, the Arikara on the Missouri, and the

in the ground. The tops are joined by beams and on these the upper ends of the rafters rest. The outer ends of the rafters are supported on poles which in turn rest on forked posts set around the outer wall of the house. The roof is first covered with poles and brush and then with earth. The houses of the upper Missouri region were large enough to accommodate several families. The favorite horse was sometimes stabled in the house at night to guard against theft. Some of these houses had their earthen floors excavated to the depth of three or four feet. Houses of this sort are entered by a ladder through the smoke hole which is in the center of the roof. The houses in the Thompson River

INDIANS OF THE EARLY WEST

This interior of a Mandan house is reproduced from an engraving by Carl Bodmer, a Swiss, who accompanied Maximillian, Prince of Wied, on his visit to the Missouri River in 1832-34. The framework of four posts and cross beams supports the roof. Note the two horses sheltered within the house

American Museum of Natural History

A CEREMONIAL LODGE

The interior of a Navaho house built for conducting a ceremony. A sand painting is being constructed with dry colors. It represents a whirling log, on the ends of which pairs of divine beings are sitting, and from the angles of which stalks of corn are growing

region are of this semi-subterranean type.

Along the Pacific coast from northern California to the Alaskan Peninsula, houses were built of split planks. The houses of the Klamath River region had the roofs in three sections, the uppermost one being nearly flat. The end and side walls were of planks stood on end, and the roof of planks ran from the eaves to the ridge. A pit was excavated to considerable depth and lined with hewn planks. These houses were for single families, being about 20 feet square; the excavated part, which was the room available for living purposes, was about 12 feet square.

About Puget Sound were again multiple houses. These were rectangular and were placed with one long side, the higher one, facing the stream or beach. The back side was lower so that the roof sloped from the front to the back. One house, no doubt an exceptional one, is reported to have been 60 feet wide and 520 feet long. Such a house was partitioned with hung mats so that each apartment was a cross section with its separate house fire. The walls were of split planks placed horizontally and held in place by lashing them between two poles. The roof planks were curved and laid reversed and overlapping like tiles.

Farther north along the coast the

HAIDA HOUSES

These houses at Tanu, Queen Charlotte Island, British Colombia, which are now falling into ruins, show excellent examples of totem poles and their use in connection with the houses. The lumber used for the houses was obtained by splitting red cedar logs and smoothing them with chisels and adzes

A WINTER SCENE
This picture, also by Carl Bodmer, represents a group of earth lodges in a Hidatsa winter village

houses had a very different structure. The main frame consisted of four posts in two pairs, the pairs being separated by the depth of the house. On these pairs of posts rested two long, large, round beams which supported the roof of the house. In earlier times the end and side walls were of split planks placed horizontally. More recently the planks have been placed upright. Such houses as these of the Pacific coast required a great deal of hand labor to fashion the lumber and erect the house. The owner would accumulate property for some years before beginning, and then, after the frame was up, he would discontinue the work while enough wealth was obtained to provide the walls and roof. The four supporting posts were usually carved and a tall pole was erected in front of the houses of the nobles. These are the totem poles for which the region is famous. The poles standing outside had the coat of arms of the husband and wife or some incident from the ancestral myth carved on them. Such a house held one principal family and several dependent ones and was controlled by a house chief.

It is in the Southwest, in Arizona, New Mexico, and southern Colorado and Utah, that the most remarkable dwellings are found. The crowning period in Southwestern architecture was sometime before the Spaniards entered that region in 1540, probably some centuries before. These structures may be divided into two classes according to whether they stood in caves under overhanging cliffs or were in the open. In either case the walls were of stone and the ceilings or flat roofs were of beams covered with poles, brush, and trampled clay. These cubical rooms were joined to each other and superimposed on one another, so that a vast structure was formed with several stories, the upper ones terraced back.

Of those standing in caves, the Cliff Palace of Mesa Verde is one of the largest.

Courtesy of the Museum of the American Indian

A SANTA CLARA WOMAN AT HER DOORWAY

The men of Santa Clara usually set up the framework and lay the bricks. The women do the plastering inside and out, their hands being their chief tools. This was true in the days of the cliff dwellers, for the finger-marks of the women still remain on the walls

Courtesy of the Museum of the American Indian

AN APACHE HOUSE

In Arizona a fairly simple house answers every purpose of the Indians. At night they feel quite secure if shut in from view, and their days are spent out of doors. They have but little to store away, and the corn after harvesting is kept in pits dug at some distance from the house

Courtesy of the Museum of the American Indian

A NAVAHO HOGAN

The Navaho Indians of New Mexico and Arizona live during the winter in more or less conical houses covered with earth. There is a large smoke hole in the roof and a door toward the east. These houses are permanent until some one dies in them; then they are abandoned

Courtesy of the Museum of the American Indian

A HUPA HOUSE

In northwestern California, houses of this type were built. The doorway is circular, made small enough to prevent the entrance of grizzly bears. A room smaller than the house itself, excavated in the ground within the frame shelter, serves as the real living quarters

The cave is 425 feet long and 80 feet wide at the widest part. The building has 117 ground-floor rooms. The walls are of well-dressed sandstone laid up in adobe mortar. The buildings standing in open country are designed with a view to defense. They are usually built around a court back from which they are terraced, the exposed outer wall being sheer and practically unpierced with doors or other openings. The ruin known as Aztec, explored by the American Museum, is 359 × 280 feet, the court being 200× 180 feet. The individual rooms are quite small, so that a large population was accommodated in such a building. Another notable ruin is called Pueblo Bonito, and is situated in Chaco Cañon, New Mexico. It is semicircular in ground plan, terraced back from the court to a high curved outer wall. In the case of both these ruins the court was protected by a row of rooms closing the exposed side. It appears that these buildings were not designed and built at one time. The general plan was laid out and then the buildings were extended as more space was needed. In the case of Aztec there were two periods of occupation, the first by people from the south related to the Chaco Cañon people and later by a people from the north who were connected with Mesa Verde, where the Cliff Palace is situated.

At the present time there are similar buildings, known as pueblos, which house the Indians of this region. Those in New Mexico are scattered along the Rio Grande; one, Acoma, is on a high mesa; Zuñi is on the headwaters of the Little Colorado near the Arizona line. In Arizona are three mesas on which stand eight Hopi villages. These are built much like the pre-Spanish pueblos, but with less care and skill.

Such close living is accompanied by a

LIFE ON THE PLAINS

A rendering by Bodmer of the home of an Assiniboin chief. Dogs are shown with travois, primitive contrivances for transporting property without the use of wheels

AN ENCAMPMENT

Another picture by Bodmer showing a village of skin-covered tipis. A hunting party is returning the spare horses laden with buffalo skins and probably also with meat

closely knit social organization and a well developed political system.

By no means all the varieties of dwellings have been mentioned, but a considerable range in material, size, and architecture has been demonstrated. It is also striking that there is no common element which is characteristic of American dwellings that may be cited as a common bond of unity. There is the lack of keystone arches in stone and the entire lack of chimneys, but then, even chimneys in the present sense were unknown in Europe in the Middle Ages.

In the May-June number of NATURAL HISTORY will appear an article by Dr. Morton C. Kahn, of Cornell University Medical School, on the Bush Negroes of Dutch Guiana, and several articles on American aborigines will be published in the July-August number.

A THOUSAND MILES OF CORAL REEF

The Marvelous Natural Structure Built by the Lowly Coral Animals and Known as the Great Australian Barrier Reef

By ROY WALDO MINER
Curator of Marine Life, American Museum

WHEN Columbus aroused Europe by demonstrating that the ocean, far from setting a barrier to man's conquest of the globe, was actually an avenue to hitherto unknown lands of continental vastness in the West, the vision of European navigators, suddenly expanded by his discoveries and the subsequent voyages of Vasco da Gama, Balboa, and Magellan, pictured beyond the vast oceans traversed by them, the shadowy form of a great southern continent, or Terra Australis, balancing the globe in the neighborhood of the Antarctic Circle. During the fifteenth century, these imaginings apparently resolved themselves into persistent tradition, due perhaps to rumors of Spanish and Portuguese sailors wrecked or escaping with difficulty the complicated reefs and shoals of a vast shore south of the Indies. In the following century, Dutch vessels setting forth valiantly to extend their East Indian trade, stumbled upon the northern Australian shores, and soon many miles of the western coast were known to their vessels. The English followed hard on the heels of the Dutch, but during the seventeenth and most of the eighteenth centuries, New Holland, as it was called, was a vast region of unknown extent. It was not till 1770 that the eastern coast was discovered by Captain James Cook. He was sent out by the British government with a definite commission to test the existence of a great south Pacific continent, and after charting many of the oceanic archipelagoes of the South Seas, he reached Australia and discovered its eastern coast. We have him to thank for our first knowledge of that remarkable coral formation known as the Great Barrier Reef of Australia, by no means the least marvelous of the many natural wonders of that amazing island continent. It is by far the largest barrier reef in the world, extending for more than 1250 miles along the eastern shore of the mainland. It is entirely included within the boundaries of Queensland, and aside from its interest as a natural feature, the products associated with the reef form a commercial asset of no mean importance for that colony.

After Saville-Kent

A TYPICAL SPECIMEN OF BÊCHE DE MER, OR TREPANG

This species, the snakelike bêche de mer (*Holothuria coluber*), though not itself greatly sought for, is closely allied to several species of commercial value, and illustrates well their general appearance. Its leathery, snakelike body may be a foot and a half or two feet in length, and is covered with wartlike papillæ, which may be extended as "tube-feet," to aid it in locomotion. At one end may be seen the brushlike tuft of oral tentacles, by means of which it secures its food

Australia itself, as everyone knows, is the only great continental division situated

After Saville-Kent

A TYPICAL VIEW ON THE GREAT BARRIER REEF AT PORT DENISON, ON THE NORTH QUEENSLAND COAST

A splendid example of coral barrier reef development as exposed at low tide. The circular expanded fronds of a beautiful madrepore (*Acropora convexa*) are everywhere evident, their surfaces closely crowded with serrate, steeple-shaped coral tips. These corals resemble spreading masses of flower-like bloom, the tiny steeples varying in color from rose through red-brown and green shades, all tipped with bright yellow. In the distance may be seen the quiet waters of the lagoon, and beyond rise the mountains of the Australian mainland

MAP SHOWING POSITION OF THE GREAT BARRIER REEF OF AUSTRALIA
This reef extends for more than 1250 miles along the eastern shore of Queensland

entirely within the southern hemisphere, being included comfortably between the tenth and fortieth parallels of south latitude, if one does not reckon in Tasmania. Thus Melbourne, its most southern port, corresponds roughly in latitude to Atlantic City, N. J., in the Northern Hemisphere, while its northern extremity, situated well within the tropics, is comparable to the island of Trinidad, off the coast of British Guiana.

In other words, if the continent of Australia were reversed and placed in a homologous position in the Northern Hemisphere, it would set neatly into place in the North Atlantic Ocean, with Melbourne in a line with Atlantic City, and Cape York north of Brazil and immediately east of Trinidad. The climate likewise corresponds with this situation, grading from equable temperate at Melbourne, to decidedly tropical as one proceeds northward. Two-thirds of the colony of Queensland is within the tropics, and it is along the coast of this portion that the Great Barrier Reef is situated.

The reef is entirely of coral formation; that is, it is built up of the limestone skeletons of coral polyps, the calcareous deposits in the tissues of corallines and other lime-depositing sea plants, the shells of mollusks, wind-blown coral sand formed by ground-up fragments of the above creatures, minute skeletons of semi-microscopic animals, the foraminifera, and, in the shallower warm lagoons, by direct deposition of carbonate of lime from supersaturated sea water. The operations of the reef-building coral organisms are carried on only in warm waters which average at least 68° Fahr., and from the low-tide mark to a depth of not more than twenty fathoms. Hence they are formed only on the shallow submerged margins of oceanic islands

and continents within the tropics and usually where they are exposed to prevailing winds and currents. These bring them in greatest abundance the microscopic organisms which form their food, while the boiling surf, dashing upon the outer reef, is well supplied with oxygen. In such exposed situations, likewise, the growing coral polyps are less likely to be choked by silt and sand. Hence they grow most abundantly on the outer margins of the oceanic shelf and tend to form a living barrier awash at low tide, parallel to the land, and at some distance from it. The barrier is always separated from the mainland by a channel or lagoon, floored by the more slowly growing corals.

In the case of the Great Barrier Reef, this is a continuous waterway, beset, it is true, by complicated shoals, but nevertheless navigable for ocean-going vessels throughout its entire length, provided they are guided by skilful pilots. The Australian government maintains an efficient system of lights and channel markers for the benefit of mariners. The distance of the reef from the coast varies from a minimum of about ten miles at Cape Melville to more than a hundred miles at the northern and southern extremities, where it bends away from the coast. The average distance of the northern half, however, is quite constantly between thirty and forty miles, while farther south it approximates sixty miles, gradually attaining the maximum distance toward the southern end. It is manifest that the

After Saville-Ken

A SCENE ON SKULL REEF AT LOW TIDE

This islet, situated on the outer barrier, is uncovered only at low tide. It has received the name Skull Reef because the many dome-shaped corals exposed, belonging to the genus *Goniastræa*, have a superficial resemblance to bleaching skulls of giant human beings

After Saville-Kent

NATIVES OF WARRIOR ISLAND PREPARING BÊCHE DE MER FOR THE CHINESE MARKET

This island, situated in Torres Strait, is one of the most important centers of the bêche de mer industry. Fleets of native schooners, fishing along the reefs, bring in cargoes of bêche de mer, which the natives boil in huge kettles like those seen in the background. The bêche de mer are then taken out, slit open, and the viscera removed, after which they are dried in the sun. Finally they are taken to the smokehouse where they are thoroughly cured and prepared for packing for transportation to Hong Kong and other ports. They are much desired as the basis for a soup which is considered a great delicacy

lagoon or protected body of water enclosed by this enormous reef must be of considerable area. In fact, Saville-Kent estimates it at more than 80,000 square miles.

The reef itself is not a continuous wall at the water's surface, but is really a series of countless reefs. The outer line of the main reef is broken by channels, while immediately within are numerous secondary reefs forming parallel lines with the outer barrier. At intervals are channels or passageways, a few of which are well known to mariners as passable for larger vessels.

Occasionally islets of various size occur, formed by coral fragments heaped up by storms until they have projected sufficiently above sea-level to entangle sand and silt and to retain the seeds of various terrestrial plants until a growth of vegetation has been established.

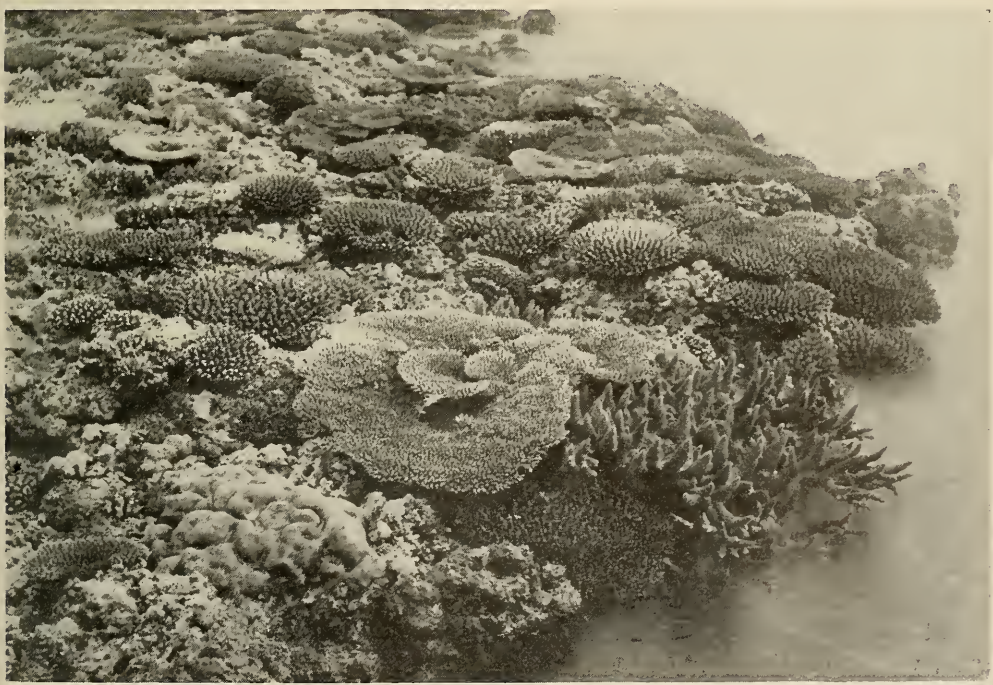
Within the reef the waters are calm and peaceful during the greater part of the year, but outside, the restless surf of the Pacific dashes against the Barrier, and the combination of winds, strong tides, and cross currents renders navigation dangerous. Even in the quiet waters within the reef are many lurking perils due to concealed shoals and "niggerheads," and it is necessary to maintain a careful lookout. The intrepid Captain Cook learned this to his cost, for his account of his careful exploration of the coast-line is filled with incidents of perilous negotiations of narrow passageways in the reef, of running

aground under difficult circumstances, and of damages to his doughty vessel, the "Endeavour," which would have amounted to shipwreck, were it not for the resourcefulness of skipper and crew, and their skill in repairing their craft.

The vast majority of the reefs are submerged or exposed only at the lowest tides. The channels between these form a veritable labyrinth, and the magnificent sea-gardens with which they are floored tempt the visitor to forget the difficulties and perils of navigation.

The exposed portions of the reefs, especially those that are storm-beaten, are not particularly attractive from the viewpoint of the naturalist interested in coral growths, but the more sheltered locations are remarkable for the beauty of their fauna, especially those open to free circulation of the incoming waves without being exposed too greatly to their destructive influence. The journal of Professor J. B. Jukes, naturalist for H.M.S. "Fly," which explored the reefs from 1842 to 1846, may be quoted here:

In a bight on the inner edge of this reef was a sheltered nook, where the extreme slope was well exposed, and where every coral was in full life and luxuriance. Smooth and round masses of Mæandrina and Astræa were contrasted with delicate leaflike and cup-shaped expansions of Explanaria, and with an infinite variety of branching Madræporæ and Seriatoporæ, some with mere finger-shaped projections, others with larger branching stems, and others again exhibiting an elegant assemblage of interlacing twigs of the most delicate and exquisite workmanship. Their colours were unrivalled—vivid greens contrasting with more sober browns and yellows, mingled with rich shades of purple, from pale pink to deep blue. Bright red, yellow, and peach-coloured Nulliporæ clothed those masses that were dead, mingled with beautiful pearly flakes of Eschara and Reteporæ; the latter look-



After Saville-Kent

MADREPORE AND PORITES CORALS GROWING LUXURIANTLY ON A PROTECTED CORAL REEF

They are shown as they appear when laid bare by the lowest tides. If exposed too long the corals die, and their skeletons become bleached to a snowy white. While living, the animal layer of each coral frond clothes it with glowing color, which varies in the different species, and even within the same species, so that a luxuriant reef resembles a garden of marine flowers

Photograph by Saville-Kent

RAISED CORAL REEF COVERED WITH VEGETATION

When coral masses have been heaped up by wave action or raised through geologic agencies, islets are formed upon which seeds of tropical plants take root. Thus a growth of vegetation is started, which soon becomes established and fits the newly formed land for human habitation. Australian natives with a dugout canoe are shown in the foreground. For a long time such natives were used as divers in the pearl fisheries of Australia. More recently they have been replaced by Japanese

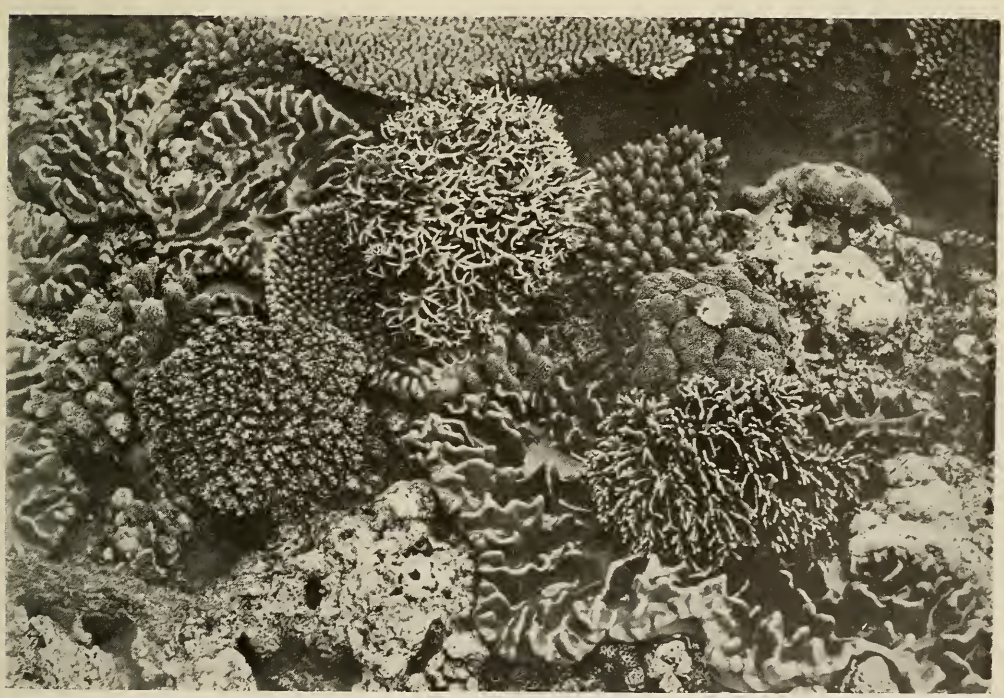
ing like lace work in ivory. In among the branches of the corals, like birds among trees, floated many beautiful fish, radiant with metallic greens or crimsons, or fantastically banded with black and yellow stripes.

Saville-Kent, in his monograph on the Great Barrier Reef, states that even on the sides of the reef exposed to the breakers at the lowest tide mark, delicate and apparently easily injured species are found flourishing beside the more robust types. This accords with my own observations on the outer and most exposed side of the Andros barrier reef in the Bahamas, where, with the aid of the Williamson submarine tube, we sat on the floor of the sea, at depths ranging from fifteen to thirty feet, and saw the most luxuriant growths of delicate and fragile branching corals growing around and in front of the giant trees of the palmate elkhorn coral. This was outside the windward face of the reef, on the verge of a precipitous drop to a depth of one thousand fathoms. Doubtless if one could descend the face of the Australian barrier below the force of the breaking surf, similar conditions would be found. Very likely, associations of coral would occur comparable to those described by Saville-Kent, as seen by him in more sheltered portions of the reef that were permanently submerged. "Their sloping edges," he says, "down to a depth of three or four fathoms, as seen on a calm day over the boat's side, often reveal terrace upon terrace, or literally hanging gardens, of coral growth of every form and color. . . . One almost perpendicular bank may be almost completely covered with the spreading vasiform coralla of *Madrepora surculosa* or *pectinata,* usually

of a pale-lilac or pink-brown hue, with pale-primrose or flesh-pink growing edges. . . ."

Another bank may "include robust branching staghorn varieties, resplendent with intermingling tints of electric-blue, grass-green, and violet. . . ."

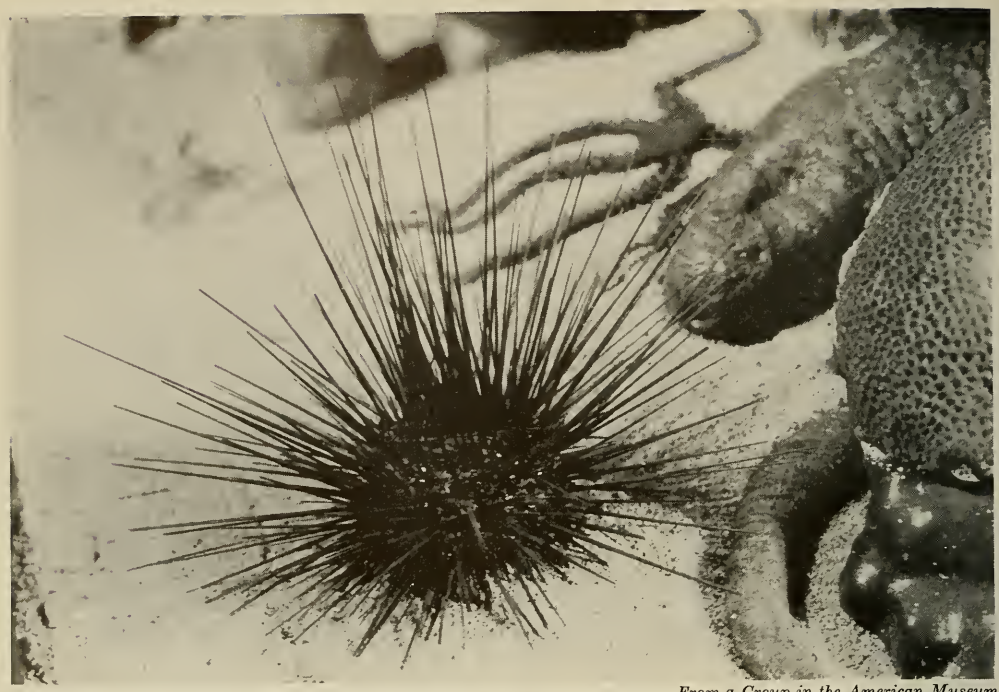
In the pools and submerged crevices are many remarkable forms of life, living in association with the coral growths. Sea anemones, varied in form and brilliant in color, exist in large numbers, spreading their living flower-like discs to suggest gardens of dahlias. Some of these have subdivided, fernlike tentacles capable of giving a powerful, burning sting, producing a rash on the skin like that of nettles, which will remain several days. The giant sea anemone (*Discosoma haddoni*) has an enormous disc, a foot and a half in diameter, covered over with thousands of spherical, beadlike tentacles mounted on tiny stalks. These tentacles are green or purple, while the mouth region is brilliant orange. A species of fish (*Amphiprion bicinctus*), brilliantly red, with two conspicuous white bands surrounding the body, lives in the stomach cavity of the anemone, and swims out from time to time, returning immediately to its shelter within the stomach of its host. It is suggested by Saville-Kent that this commensal partnership between these very diverse animal forms is of benefit to both in this way: The brightly colored fish acts as a lure to other larger species, which dart to seize it and are immediately stung by the anemone and appropriated for food. The fish partner meanwhile is protected by its host and possibly shares



Photograph by Saville-Kent

DETAIL SHOWING TYPICAL REEF CORALS

Pocillipores, galaxea, madrepores, and nullipores are represented. These are various genera of reef-forming corals, except the nullipores (sea plants), the cells of which are impregnated with calcareous material, and superficially resemble coral growths. The symmetrical clusters of finely branching white filaments in the upper center and lower right of the photograph belong to this group of sea plants, which are important factors in reef formation



From a Group in the American Museum

THE SLENDER-SPINED SEA URCHIN

Diadema setosum

A common inhabitant of coral-reef lagoons throughout the tropical waters of the world. Its needle-like spines readily pierce the feet or ankles of the unwary wader. Near by may be seen a brittle-star. and the elongate, leathery body of a bêche de mer, or sea cucumber

fragments of the prey. It is never harmed by the stinging cells of the anemone. Some individuals of this species of anemone entertain as guest a little transparent prawn of the genus *Palæmon*. Like the fish, it has brilliant red markings, but fish and prawn are never found in the same anemone. There is a still larger anemone (*Discosoma kenti*) measuring two feet in diameter, covered with golden-brown and blue tentacles, tapering in shape. This species is also host for a fish (*Amphiprion percula*), vermilion like the other species, but with three white bands instead of two. Sea urchins, sea stars, and sea cucumbers are abundant among the corals. The former includes the ubiquitous slender-spined urchin (*Diadema setosum*), found all over the world in tropical waters. Its long, needle-like spines menace in all directions, and, at the slightest touch, pierce the foot or ankle of the unwary wader. Another sea urchin, the slate-pencil urchin (*Heterocentrotus mamillatus*), has thick, cylindrical spines, blunt at the tip, strongly suggesting those implements useful to the school boy of a past generation. Sea stars, scarlet, blue, or brown, also give diversity to the reef. The giant sea cucumber (*Synapta beselii*) coils its knobbed, orange-colored convolutions through the crevices of dead coral, expanding a graceful feathery crown of tentacles like a passion flower. Green, brown-spotted, and orange bêche de mer stretch their fringed and papillate bodies over the sand like decorated sausages, mopping up food particles from the sea bottom with their brushlike tentacles. One species of bêche de mer (*Holothuria mammifera*), mottled gray and black, acts as a commensal host to a small

tapering fish of the genus *Fierasfer*, which inhabits its branchial cavity. These are but a few of the remarkable creatures common in the Great Barrier Reef.

The most valuable products of the Great Barrier Reef from a commercial standpoint are pearls and pearl shell, bêche de mer, oysters, and food fishes.

Australia possesses the most extensive pearl-oyster grounds in the world. The most important fisheries are those of Queensland and Western Australia, said to be of about equal value. The Queensland fisheries have their principal headquarters at Thursday Island, in Torres Strait, which separates Cape York, the northernmost point of Australia, from the southern coast of New Guinea. To reach this strait from the Pacific it is necessary to pass the dangerous ramparts of the extension of the Great Barrier Reef which sweeps northward, nearly to the New Guinea shore. After the reef is passed, the funnel-shaped entrance of the strait is found to be practically choked with thousands of islets and reefs separated by tortuous channels, only a few of which are navigable to large vessels. The safer entrance is by way of the ship channel inside the Barrier Reef from the south, along the Queensland coast. By pursuing this route, after leaving Cooktown, as one sails northward, the vessel passes through the eastern portion of the pearl fisheries grounds, which are practically continuous from here around the peninsula of Cape York, along the entire northern coast of Australia, and down the western coast to

THE GIANT SEA ANEMONE OF THE GREAT BARRIER REEF
Discosoma haddoni

This photograph is from a life-size model in the American Museum of Natural History. The great flower-like disc of this creature is a foot and a half in diameter, and is covered with thousands of bead-like tentacles, varying from purple to green in color. These are armed with sting-cells which slay or stupefy fish or small sea-animals which form its food. One species of fish (*Amphiprion bicinctus*) brilliantly banded red and white, is immune to the stinging organs of the anemone, and lives within the creature's stomach, swimming in and out of its centrally located mouth at will

RELIEF MAP OF TWO SMALL PACIFIC ISLANDS OF THE SOCIETY GROUP, RAIATEA AND TAHAA, SHOWING THE BARRIER REEF BY WHICH THEY ARE SURROUNDED

The coral animals lay down deposits of limestone beneath their bodies. These deposits form branching or leaf-shaped expansions, or dome-shaped masses, according to the species. They accumulate on the submerged banks of islands and continents in tropical seas. At first these form fringing reefs close to the shore, but later they form a barrier reef paralleling the coast at some distance, enclosing a channel or lagoon between it and the shore. In the map a lagoon or channel is visible between the barrier reef and the islands, while a narrow fringing reef is seen close to the shore. The Great Barrier Reef of Australia is formed in a similar way, but on a vastly larger scale. It extends for 1250 miles along the Australian shore, and the enclosed channel varies from ten miles to more than a hundred miles in width. This map is on exhibit in the American Museum

Shark Bay. The fisheries were formerly carried on by Australian natives under the supervision of whites. Later Malays, Cingalese, and Pacific Islanders were extensively employed, while Japanese were gradually brought in increasing numbers, until now they predominate, and, in fact, practically monopolize the industry. This, doubtless, is due to their characteristic efficiency. In 1905, according to Dr. George F. Kunz, the Queensland fishery employed 348 vessels and 2850 men, while the commercial value of pearls and pearl shell harvested was about $675,000; that of Western Australia, about $958,000; and that of Southern Australia (also carried on on the northern shore of the continent), about $125,000. Thus the entire Australian pearl industry yielded about $1,778,000 in that year. These figures fluctuate and, in recent years, the output has decreased due to the exhaustion of many of the beds.

The Australian pearl oysters belong to three species, of which the largest and most valuable (*Margaritifera maxima*) is known commercially as the "silver lip," because of the silvery white iridescence over the entire inner surface. Next in value comes the "black lip" (*Margaritifera margaritifera*). This is characterized by a dark border around the inner edge of the shell. The third species (*Margaritifera carcharium*) is the smallest and least valu-

able, so far as its shell is concerned, but yields a higher percentage of pearls than the other two species. The "silver lip" shells yield the largest and finest pearls in the world, according to Doctor Kunz, while the shells themselves form the standard mother-of-pearl of commerce. Their annual value is several times that of the pearls found in them, in spite of the quality of the latter.

The pearl shells were originally secured by employing nude divers, who became very skilful in the very laborious and perilous art of diving, often to depths of sixty feet or more, to return to the surface with one or two shells at a time, or, more frequently, with none at all. The average time spent by a diver under water was fifty-seven seconds to a minute, though some South Sea natives have been known to remain under for nearly three minutes. In some cases, the diver would take a stone attached to a cord as a weight to carry him down more quickly, but in most cases he would dive feet first, turning head downward after descending a short distance and swimming the rest of the way. A few seconds only would be spent at the bottom groping for a shell or two. These would be placed in a fiber basket or secured under the arm, and then the diver would spring toward the surface. As long as he held his breath he would shoot upward rapidly, but if he failed to gauge his time accurately and let his breath go before reaching the surface, he would sink again, and, if not rescued, would be lost. Many such fatalities inevitably occurred during the course of the fishing. More recently, however, diving

After Saville-Kent

WRECK OF THE MISSION SCHOONER "HARRIER"

This vessel, belonging to the New Guinea Mission Service, was wrecked not far from Cooktown, on one of the many reefs, hidden except at low tide, which render the passage of the inner channel dangerous. On this occasion the crew of the vessel was rescued without loss of life. Many ocean-going vessels of considerable size have not been so fortunate, for hundreds of lives have been lost and much treasure has gone to the sea-bottom in the attempt to navigate the intricate channels of the Great Barrier Reef. The Australian government has installed many lights and markers to increase the security of vessels passing the channels

After Saville-Kent

OUTER BARRIER REEF SHOWING LIVING BÊCHE DE MER CRAWLING ON THE SEA-BOTTOM

The bêche-de-mer, or trepang, is a sea cucumber with leathery skin, furnished with many "tube-feet" along its outer surface, each equipped with a terminal sucker. By means of these organs the creature drags its body over the sea-bottom, mopping up the sand particles and the minute creatures clinging to them, which form its food. This is accomplished by a brushlike circlet of tentacles surrounding the mouth at the forward end of the body. The bêche de mer, when extended, may reach a length of from eighteen inches to two feet. Native fishing schooners may be seen in the distance fishing for these animals, which are cured and prepared for the Chinese market. The species shown in the above picture is popularly known as the "ordinary red-fish" (*Actinopyga obesa*), one of those most sought for commercially

suits of various types have been employed, and these are now generally used, thus decreasing the danger, and promoting much greater efficiency in collecting the shells. On the other hand, more effective methods and the rapid increase in the number of pearling luggers employed, especially by the Japanese, have resulted in the depletion of the beds, and some of the fleets have been drawn away to the Philippines and other regions.

The bêche de mer industry is a peculiar but profitable one. These animals, which are also called trepang by the Malaysians, are large sea cucumbers belonging to the family Holothuridæ. As stated above, they somewhat resemble huge sausages lying in shallow pools or lagoon bottoms among the coral reefs. Several species are used, readily characterized by their coloring or markings, or by surface projections of various types. As they are echinoderms, their leathery body is provided with numerous "tube feet," slender appendages terminated by sucker-like discs. These organs are arranged in five bands along the sides of the body and enable the animal to pull itself along the sea bottom. At one end of the creature is a circular mouth surrounded by a fringe of tentacles, by means of which the animal's food is secured. This consists mainly of Foraminifera, microscopic animals possessing a chambered, calcareous shell.

The holothurian obtains them by mopping its tentacles back and forth over the sand. These pick up sand and the other particles with which the Foraminifera are entangled, and transfer them to the mouth in ordered succession, returning to the quest again in reverse order. The Queensland natives gather the trepang into sacks, wading in the pools among the rocks at low tide, or diving for them in deeper water. They are then immediately conveyed by a fleet of luggers to curing stations, where they are boiled for a time in large kettles. Next, they are cut open, dressed, and dried in the sun, after which they are transported to smokehouses, where they are smoked on racks of wire netting for twenty-four hours, over a fire of red mangrove wood. They are then in a thoroughly dry, shrunken condition, and are ready to be packed into sacks and sent to the Hong Kong market. They are highly prized in China, where they form the basis of bêche de mer soup. When this is properly prepared it has the reputation of being more delicious than turtle soup. There is also a considerable market for them in Australia, the Pacific Islands, and in American Pacific Coast cities. In Queensland, they form an industry ranking with the oyster fisheries in commercial value.

Several varieties of oysters grow in great abundance in the Great Barrier Reef region. The most important commercial species is the so-called common rock oyster (*Ostrea glomerata*). This forms the basis of an extensive and valuable commercial fishery comparable with that of the Virginia oyster (*Ostrea virginiana*) of the United States, with which it seems to be closely related. The fishery centers about the Moreton Bay district where the mollusks are dredged from submerged beds or are fished from oyster banks exposed at low tide. In the latter case they are also cultivated with success. The bank oysters appear to be the most profitable. The shells are attached to stones or dead oyster shells as a clutch, or the "spat" (young) frequently settle down on the shell of a species of whelk (*Potamides ebeninus*), which abounds in the neighborhood of the oyster banks. The whelk carries about with it a load of the young oysters, which are thus provided with free transportation to pastures new and advantageous, and therefore thrive exceedingly. As they increase in size and weight, the poor whelk's burden in life becomes overwhelming. Soon it can no longer maintain itself on the surface of the soft mud of the bank and so gradually sinks down to perish, forced into its grave by its thriving burden. Saville-Kent states that frequently the load of oysters borne by a living whelk weighs half a pound, while their downtrodden beast of burden weighs scarcely an ounce. This is so frequent an occurrence that entire oyster banks are known as whelk-oyster banks. There are several other species of oysters found throughout the Barrier Reef area but, for one reason or another, their commercial importance is not so great.

As might be expected, the food fishes of this remarkable and productive region are very numerous and greatly diversified. Even in Saville-Kent's time, the fish fauna of Queensland alone, including fresh-water and marine forms, had reached practically 900 recorded species, of which upward of one-third, or 300 species, are of definite food value. These, as would be expected from the tropical climatic conditions of the colony, largely belong to the Indo-Pacific fauna. Probably the most important commercially are the members of the perch family, of which more than seventy species are of economic food value. A splendid example of this group is the giant perch (*Lates calcarifer*) which reaches five feet in length and a weight of more than fifty pounds. It is an excellent food fish. The gayly colored sea perches of the family Serranidæ are especially

abundant in the neighborhood of the Great Barrier Reef, and include at least twenty species, most of which are highly esteemed from a culinary standpoint. Red mullets, sea breams, banded doreys, red rock-cods, tassel-fishes, and jew-fishes are common and, though unfamiliar to American readers, are nevertheless characteristic and important items on the Australian bill of fare. Types allied to our horse-mackerels, barracudas, yellowtails, and bonitos are of frequent occurrence, while flatfishes, herrings, and eels are also well represented in their Australian counterparts. These, and numerous other species render the Australian food fisheries of great economic importance.

The Great Barrier Reef, therefore, is not only a most interesting feature from the standpoint of the zoölogist and geologist, but its 1250 miles of reefs and lagoons form a veritable treasure house of natural resources for the great Commonwealth of the Southern Hemisphere.

NOTES

ASTRONOMY

Is There Life on Mars?—Prof. Frank Schlesinger, director of Yale College Observatory, addressed the Amateur Astronomers Association, at a March meeting on the subject "Life on Mars." Doctor Schlesinger said among other things:

Though Venus sometimes approaches the earth more closely than Mars, we can observe the latter far better than any other planet. Recent intensive work on the planet has shown that the conditions there are not vastly different from those on the earth. At certain times and at certain places the temperature gets up to what we would call comfortable, though at the same places at other times the temperature must descend to that of our arctic winters.

The atmosphere of Mars is much thinner than on the earth, but the essential constituents are probably much the same. It is certain that the higher forms of life on the earth would not survive for more than a few minutes at most if transplanted without modification to Mars, but our lower forms of life could prosper there, and it is all but certain that from these, higher forms would develop. But these higher forms might not resemble those that we are acquainted with on the earth and might even be constituted in such a way as to lie outside of our imagination. It is probable that such higher forms of life would develop senses beyond the five that we are acquainted with here, and these senses might be of such a character that we are not only ignorant of them but could not understand them. An analogy to this is found on the earth itself. For instance, the manner in which homing pigeons find their way back after being transported a thousand miles in covered boxes seems to be beyond our comprehension. Furthermore, comparatively high forms of life have invaded portions of the earth which at first sight would seem absolutely impossible. For example, life of highly complex form has penetrated to the very depths of the ocean, where the conditions differ more from those in which we live than the latter do from the conditions on Mars. While it is probable that Mars is inhabited by forms of life one or some of which may possess intelligence equal to or greater than our own, attempts to communicate with such beings by radio or otherwise seem all but certainly doomed to failure.

At the meeting of May 3, four reels of astronomical motion pictures made at the Mount Wilson Observatory, near Pasadena, California, will be shown. These will illustrate the use of the instruments of the astronomer's work-shop, and will also show some of the wonders of the sky as seen through the largest telescope in the world.

At the May 17 meeting, Professor J. Ernest G. Yalden will speak on "Astronomy in Navigation," illustrated with lantern slides.

In continuation of the regular work carried on at the bi-monthly meetings, summer activities of the Amateur Astronomers Association will be undertaken in coöperation with the Nature Trail of theAmerican Museum at Bear Mountain, Palisades Interstate Park. An astronomical telescope will be available for use under the direction of Mr. William H. Carr and his associates with the occasional assistance of members of the society, whose lectures will be announced later.

BIRDS

Dr. Frank M. Chapman returned to the Museum on April 10 from a winter on Barro Colorado Island. While there he devoted himself exclusively to field studies, focusing his attention on the nesting habits of the oropendola (*Zarhynchus wagleri*), a member of the oriole family. The present year completes Doctor Chapman's third season's study of this species, and he is now in possession of data which not only cover the habits of this species, but show its relation to other forms of life with which it is associated.

COMPARATIVE ANATOMY

A BABY SPERM WHALE (*Physeter macrocephalus*) nineteen feet long was captured and towed into the Gowanus Canal, New York Harbor, by some longshoremen on March 13.

When the tide receded, the animal stranded and died. The American Museum of Natural History bought it from its captors and had it brought by truck to the Museum, where it was placed in the Hall of Ocean Life. A cast was immediately made by members of the department of preparation and the whale was then dissected by Mr. Raven. The most important anatomical features observed were in connection with the respiratory apparatus. The interesting arrangement of the little understood nasal passages was studied and the right nasal passage, which had hitherto been supposed rudimentary, was found to be well developed, and its position beneath the spermaceti organ was established. The left nasal passage, on the other hand, proceeds from the blow-hole backward and downward on the lateral surface of the spermaceti organ. A report on certain details of the anatomy was made by Mr. Raven at the annual meeting of the American Society of Mammalogists held in Washington, April 12.

CONSERVATION

MADISON GRANT in a letter to the editor of the *New York Times* has called attention to the necessity for conservation of our forests, especially privately owned timber land included in our National Parks. He says in part:

What is left of our national heritage of forest must be carefully guarded. In the past, Americans have cheerfully squandered their natural resources of timber and wild life and are now entering upon a period where millions must be spent to restore what has been needlessly destroyed.

The sugar pine and the white pine of the Sierras are among the grandest trees in the world, ranking in majesty second only to the giant sequoias themselves. They are national monuments, and a wiser and riper civilization will regard their destruction as a shameful disgrace to the generation which permitted it.

EDUCATION

THE NATURE TRAILS AND TRAILSIDE MUSEUM at Bear Mountain on the Hudson will be open to the public from the first of May until the first of October. Mr. William H. Carr will represent the department of public education and will, for the second year, have charge of the operations.

Last season there were more than 23,000 visitors to these trails. It is hoped that this year the attendance will be doubled, due to the fact that the museum building will be open for the first time.

The trails and museum are located near the Bear Mountain Inn, and are within easy reach of the Bear Mountain Bridge.

EXPEDITIONS

CENTRAL ASIATIC EXPEDITIONS.—A cablegram from Dr. Roy Chapman Andrews states that despite the many handicaps caused by uncertain political conditions in China, the field staff of the Central Asiatic Expeditions left Kalgan April 14 to resume field work in the Gobi Desert. Prospects are bright for a successful season. The party includes Roy Chapman Andrews, leader Walter Granger, palæontologist, Alonzo W. Pond, archæologist, and Leslie E. Spock, geologist.

THE CARLISLE-CLARK AFRICAN EXPEDITION.—Through the generosity of Mr. and Mrs. G. Lister Carlisle, Jr., of New York, an additional group is being made possible for the great African Hall in the American Museum, of which Carl Akeley dreamed and to which he gave his life. Mr. and Mrs. Carlisle are greatly interested in the African Hall, and it was their desire to assist in the collection of African material that led to the formation of the Carlisle-Clark African Expedition, which leaves New York early in May.

The personnel of the expedition consists of Mr. and Mrs. Carlisle, Mr. and Mrs. Clark, Mr. R. C. Raddatz, preparator, and Mr. W. R. Leigh, artist. The plan is to spend about four months in the field, the party returning to New York the first of December. The expedition will reach Nairobi, Kenya Colony, East Africa, about the middle of June, and proceed directly to Tanganyika Territory for collecting.

Mr. Carlisle himself is an ardent photographer and is setting out for Africa well armed with both motion-picture and still-camera films.

In addition to the desired specimens and accessories specifically to be collected, Mr. Clark likewise is interested in obtaining valuable photographic records of the wild life to assist in the designing and modeling of the groups. Through his close association with Carl Akeley and his complete knowledge of the plans for the African Hall, Mr. Clark is eminently fitted to undertake the work. He has previously spent some time in Africa on two different expeditions and is thoroughly familiar with the habitats of the big game of the East Coast.

THE STOLL-MCCRACKEN SIBERIAN-ARCTIC EXPEDITION OF THE AMERICAN MUSEUM.—Curator H. E. Anthony, in charge of the scientific party of this expedition, left New York April 20, to join the schooner "Effie Morrissey" at Seattle. Mr. Harold McCracken, leader, E. M. Weyer of the

department of anthropology, and F. L. Jaques and A. Johnston of the department of preparation, accompanied him. Mr. and Mrs. Charles H. Stoll will join the party late in May in Alaska.

The department of vertebrate palæontology is sending out three men, Peter Kaisen, Ernest Kaisen, and Glen Streeter, to coöperate with the Colorado Museum of Natural History, in completing the Folsom, New Mexico, bison excavations, noted because of the association of human artifacts with an extinct species of bison.

Miss Rachel Husband is to continue the search for Ft. Union mammals in a coal mine at Bear Creek, Montana.

J. C. Blick, Charles Falkenbach, and Joseph Rooney are to continue work in the Pliocene near Keams Cañon, Arizona, and Joseph Rak will continue excavations in the Pliocene at Santa Fe, New Mexico.

HALL OF OCEAN LIFE

The Benson Murals.—The first four of a series of twelve mural lunettes in the Hall of Ocean Life of the American Museum of Natural History are to represent the historic and now defunct American sperm whaling industry. Sperm whaling, rather than right whaling, has been selected because of its great picturesqueness and its important place in discovery and in the growth of the nation. The sperm whalers of Long Island, Nantucket, and New Bedford voyaged for months and years on end throughout all the warmer waters of the globe during a period of more than a century and a half. Individual vessels not infrequently remained at sea throughout a course of three or four years, and their place in spreading a knowledge of the position and power of the then young Republic cannot be overestimated.

Quarter-sized cartoons for the four whaling panels have now been completed by the well-known marine artist, Mr. John Prentice Benson. The technical details have been supervised by Dr. Robert Cushman Murphy of the Museum staff, who spent a year on a New Bedford whaler during 1912–13. The third panel of the series, in fact, depicts the Brig "Daisy" which was subsidized by the Museum during the cruise referred to, and which captured twenty-seven sperm whales on the course of the voyage from Barbados to South Georgia.

The four paintings are designed to show the more important types of vessels employed by the Yankee whalers, as well as four characteristic stages in the adventure of hunt, capture, and disposition.

The first is a morning scene. The call from the masthead has been sounded. The boats have been lowered, and strong arms are bending double the oars as they pull toward the blowing school in the early morning light.

In the second scene, one boat is about to come to grips. The harpooner stands with the iron poised, while ahead of his boat a sperm whale is sounding, with its pointed hump just slipping beneath the choppy water.

The third painting shows the victorious whalemen towing home the dead leviathan while the noon-day sun beats down upon a glassy sea, and the sharks have followed their noses in toward the expectant feast of the cutting-in.

Finally, we have the boiling process, or the trying out of the oil. Against a quiet sunset the square-rigger lies with slatting sails hauled just aback, while the dense smoke of burning blubber-scrap floats away to leeward. This is the final stage in the disposition of the whale at sea. After the tried-out oil has been cooled and run down into the great casks below, the vessel once more starts cruising, with the mastheads manned for spouts.

HISTORY OF THE EARTH

The department of geology and palæontology is assembling machinery under the direction of Dr. Chester A. Reeds, for sectioning and polishing large specimens of fossils, rocks, and meteorites. The new equipment includes a large specially constructed band saw, two eighteen-inch polishing laps, each with a different speed, a buffing lathe with two wheels traveling at high speed, a frame for circular saws, and other accessories. When the installation is completed, the operation of the machinery will be in charge of Mr. Prentice B. Hill.—C. A. R.

MEETINGS OF SOCIETIES

The American Association of Anatomists met Apirl 5–7, at Ann Arbor, Michigan. Dr. G. K. Noble presented a paper embodying recent results obtained in experiments on factors controlling tooth form in salamanders. He showed that a striking sexual difference of the teeth was determined by the presence of the male gonads which secreted a hormone controlling the form of the teeth in the male; also that it was possible by the transplanting of gonads to change bicuspid teeth into monocuspid ones. These experiments are of interest because of the light they throw on factors controlling tooth form in general.

The American Society of Mammalogists held its tenth annual meeting in the United States National Museum at Washington, Apirl 10–14.

Of the forty-five papers presented, seventeen concerned the anatomy, habits, migrations, parasites, and utilization of whales.

Mr. William J. Morden, American Museum associate in mammalogy, delivered an evening lecture on the Morden-Clark Expedition across Central Asia. Other papers presented by representatives of the American Museum were "Life Zones on Mount Roraima" by G. H. H. Tate, "Parasites of the Whale" and "Notes on the Anatomy of a Baby Sperm Whale" by H. C. Raven, "Over-population among Microtus" by R. T. Hatt, and "Random Remarks on the Cetacea" by J. T. Nichols.

Members of the American Museum staff were well represented in a comprehensive exhibit of the work of the American Mammal Artists, which was held in connection with the meeting.

At the Sixty-sixth Meeting of the Galton Society, held March 2, 1928, Prof. William K. Gregory reaffirmed his belief that man is descended from a limb-swinging or brachiating type of anthropoid ape, broadly similar to the chimpanzee but much more primitive. He proved conclusively to all those present that the human foot is derived from a stage which he called biramous, partly because the big toe has an independent musculature from the others, also that the anatomical evidence points to an extremely long line of tree-living ancestors of the earliest pro-human stock.

As regards the hand of man, Professor Gregory believes that the thumb enjoyed a secondary enlargement and specialization for tool-making purposes.

Professor McGregor, one of the closest observers of various living forms of anthropoids, remarked that the reduction of the thumb in the anthropoid apes had been exaggerated and that the impression of the small thumb of the ape is partly due to the relative elongation of the fingers. He also showed that the ape thumb, even when reduced as in the case of the chimpanzee, is used in picking up small objects and can be trained to thread a needle. He agreed with Professor Gregory that the humerus (*brachium*) or upper arm bone of man is closely similar to that of all the anthropoid apes and nearly indistinguishable from that of the chimpanzee.

Professor Osborn read Darwin's original definition of the ancestors of man (*Descent of Man*, p. 164) as provided with pointed and movable ears and a tail. He reiterated the opinion which he has advanced for two years past that the human stock branched off from a common stock, known as the Anthropoidea or human-like animals, long before the specialized habits of the manlike apes had profoundly modified their anatomy. This separation probably occurred in Oligocene time, during the first world-wide period of aridity, in which the forest-living animals of all kinds doubtless gave off the plains and open country types. It happens that the great Shara Murun formation of Mongolia, which is extraordinarily rich in the bones of fossil mammals, belongs to this very Oligocene period, wherein, according to Osborn's theory, the separation between the so-called 'pro-dawn man' and the anthropoid apes took place. He stated that our Central Asiatic Expedition included two of the most expert fossil hunters in the world today, Mr. Walter Granger, chief palæontologist of the expedition, and Mr. Albert Thomson, both of whom had had unparalleled experience in discovering the smaller forms of mammalian life. The rarest fossil remains in the world, however, are those of the monkeys and apes; the remains of man are even more rare than those of his distant relatives. One of Chief Andrews' original objects in organizing the Central Asiatic Expedition was to discover traces of our human ancestors, near or remote, and the crowning achievement would be such a discovery!

Professor Gregory's paper was also discussed by Professor Tilney, who stated that he could not conceive of the evolution of the human brain from any type except an arboreal brain.

Professor Morton, of Yale University, discussed the four types of foot, tarsioid, simian, anthropoid, and human. His conclusion was that 'comparative analysis of primate feet not only dissociates basically the human type from the primitive and lower forms, but also it demonstrates a positive affinity between the human and anthropoid types—the anthropoid type representing the preceding stage in the course of evolutionary development of the human foot.

The Fourth International Congress of Entomology will be held at Cornell University during the week beginning August 12, 1928. Dr. Frank E. Lutz has been appointed as the official representative of the American Museum.

Prof. Charles P. Berkey, research associate in geology of the Central Asiatic Expedition staff, has been invited to take part in an arranged discussion on the geology of Central Asia at the meetings of the British Association for the Advancement of Science, which will be held in Glasgow next September. Professor Berkey will attend the convention as an official delegate of the American Museum and of Columbia University.

SCIENCE OF MAN

Dr. Margaret Mead, assistant curator of ethnology, was granted a fellowship by the Social Science Research Council at its meeting on April 7. Doctor Mead intends to leave about September 1 for one of the Melanesian islands in the South Pacific, where she will study in particular the life of children in a primitive society. Doctor Mead made a study of girls on a Samoan island in 1925–26 before taking up her duties at the Museum. Miss Mead will return to her position in the department of anthropology after a year's leave of absence.

Wooden Shield Found at Chichen Itza.—At Chichen Itza, Yucatan—one of the most famous groups of Mayan ruins—the field party from the Carnegie Institution in Washington, under the leadership of Earl H. Morris, formerly with the American Museum, discovered a wooden shield, the surface of which is inlaid with tiny squares of turquoise. This shield was in the bottom of a jar, concealed in the earthen floor of the Temple of the Warriors, one of the more interesting buildings in the Chichen series. The find is said to be one of the finest examples of Mayan art. Unfortunately, the wood of the shield was decayed so that a restoration of the piece is necessary before it can be moved. In response to a request from the Carnegie Institution, Mr. S. Ichikawa, of the American Museum staff, has gone to Yucatan to make the restoration.

Archæological Work in Asia Minor.—At the request of Dr. James H. Breasted, head of the Institute for Oriental Research of the University of Chicago, leave of absence was granted in April, 1927, to Dr. Erich Schmidt of the Museum's department of anthropology, to take charge of the archæological excavation at "Alishar Hüyük," in central Anatolia, under Mr. von der Osten, the field director of the expedition. The only other Occidentals in the party were F. M. Blackburn, the topographer, a camp superintendent, and a carpenter. For nearly six months excavations were carried on in the huge "hüyük," or city mound, with an average crew of 120 Turkish laborers.

The method of American archæology which considers an obsidian flake as important as a sculptured rock, was applied in the Orient. As was to be expected, a great number of settlements and periods of occupation were represented at Alishar Hüyük. On the summit of "Mound A" which is approximately eighty-five feet high the Romans were the last occupants. Their houses were built on top of a pre-classical citadel where were found seals with Hittite hieroglyphs. In the domiciliary mound, traces of the successive Byzantine, Seldjuk, and Osmanli occupations were discovered, and two more periods preceding the pre-classical occupation, designated periods II and I. The remains of the first settlement resemble those of Troy I, approximately 2500 to 3000 B.C. One of the most important results of the season's work was the establishment of the local periods and the relative chronology of the pottery.

COMMENDATION

In view of the criticism and unfavorable comment recently aroused by the policies of many museum collectors, the following editorial which appeared in the *Anchorage Daily Times* of Anchorage, Alaska, November 7, 1927, is most gratifying to the American Museum:

How Museum Expeditions Should be Conducted

Several months ago *The Times* published an editorial criticising the so-called museum hunter. In glaring contrast to some of the expeditions that have visited Alaska in the past was the recent expedition of Mr. Van Campen Heilner, field representative of the American Museum of Natural History in New York.

As an illustration of how the museum permit should be used, when in the hands of a bona fide representative of a great museum—who does not happen to be a game hog on the side—Mr. Heilner came to Alaska with a permit for four brown bear, a male, a female, and two cubs. He came alone. In addition to his permit, he took out a nonresident hunting license, for which he paid the regular fee of $50.00. This license permitted him to take three additional brown bear. The average person would have done so. Mr. Heilner saw nearly thirty bears and could easily have secured the three bears, that his own license permitted, but he didn't. The four bears that the museum needed were taken, and no more.

Alaskans want to encourage accredited representatives of a museum of the standing of the American Museum of Natural History in New York, to come to Alaska and secure a needed group, so that thousands may see them and by seeing them realize the wonderful possibilities that Alaska offers to sportsmen. Alaskans do not want the game hog, who through political influence secured the required permit to slaughter our game, under the pretext of representing a museum, and thus satisfy his lust for killing. Regardless of the amount of money such persons may spend on their hunt, to permit this condition is not fair to the sportsmen of America, nor to the Alaska game commission and Alaskans in general.

Mr. Heilner in addition to being on the staff of the American Museum of Natural History, is associate editor of Field and Stream. It is sportsmanship like his that is appreciated. Alaskans hope he will come back again and they will stand ready to welcome him and assist him in securing any specimens or trophies he may desire.

HONORS

At the last meeting of the American Association of Museums Dr. Frederic A. Lucas was made an honorary member. Doctor Lucas was one of the founders of the Association, the third president, and for many years took an active part in the work of the Association.

ALLEN MEMORIAL FUND

The Joel Asaph Allen Memorial Fund, created by contributions from the mammalogists of the world in memory of the late distinguished curator of mammals of the American Museum of Natural History, reached its goal at the recent meeting of the Society of Mammalogists in Washington. Ten thousand dollars have been raised for this fund, which is to be used in the publication of special papers in the *Journal of Mammalogy* in memory of Doctor Allen.

Doctor Allen, who for thirty-six years was on the staff of the American Museum, was pre-eminent in the fields of mammalogy and ornithology and was virtually the founder of mammalogy as we now know it. The scope and length of his bibliography are equalled by few men in his field of research.

The members of the committee of the Allen Memorial Fund are: Madison Grant, chairman; Henry Fairfield Osborn, Childs Frick, George Bird Grinnell, and H. E. Anthony.

BOOK REVIEW

Wild Animals Pets. By William and Irene Finley. 311 pages and more than 80 half-tone illustrations. Charles Scribner's Sons, New York, 1928.

Few human beings have had so many wild animal friends as have the Finleys, and no one has made so many good photographs of birds and animals as they. In this book they have given us an intimate glimpse of more than a score of these "children of the wild," their fascinating stories being copiously illustrated by their own appealing pictures. The foreword was written at Riverby, Jennings Lodge, Oregon, named for John Burroughs' home on the Hudson. Unlike their hero, however, the Finleys have not confined their observations to the wild life about their cabin, but have traveled from the Pacific to the Atlantic, and from Mexico to Alaska. By the way, John Burroughs, in his journal nearly twenty-five years ago, as quoted in *The Life and Letters*, predicted that this young bird enthusiast, Finley, would be heard from.

For the benefit of less experienced photo-naturalists, some good hints are incidentally given, for example, "One thing is certain—if a cub ever gets in trouble or in a tight place,—this is sound advice to any sympathetic citizen: 'Get as far away from Johnny as possible!' Trying to reason with or to be sympathetic with a worried mother bear is too much like creeping up to find out why a charge of dynamite doesn't explode."

"Coyote, the Prairie Wolf" is a dramatic story well told. The account of the chipmunks of Mount Ranier is an interesting bit of animal psychology. Surely one of the most appealing motion pictures the Finleys ever made was that of the chipmunks.

The race between the pet pronghorn and the Russian wolf-hound enthralls the reader, but the race for life between this doe of the desert with her fawns against the coyotes is dramatic beyond words.

By the publication of *American Birds* twenty years ago, William Finley established himself as a genuine field-naturalist, with a keen and sympathetic understanding, and all who have followed his activities realize that he has had an able associate in Mrs. Finley, and two fine assistants in their children.

Both of these authors are so modest that the reader gathers little notion of the great amount of time and energy that has gone into this work. The book is all the better for that fact, however, for who would refer to any enterprise by the prosaic term "work," when so much real enthusiastic play has gone into it!

Adverse criticisms, which can be made by the reviewer, are relatively so insignificant that it seems hypercritical to make them. No mistakes in natural history were noted in the entire book. However, one might infer from the last sentence of the middle paragraph of page 134, that a mole is a rodent. On page 164, why state that the pupil of the eye was black? It is always black. On page 264, it should be clearly stated that newborn opossums crawl to the mother's pouch; at least one should not be allowed to infer that the mother puts them into this nursery.

But let not these trifling matters detract from the value of the book. Here are brought together some most interesting stories of birds and animals by two outstanding and dependable field-naturalists. Although not devoted to preaching, this collection of stories will do great good with plastic youth, our future citizens, in creating an interest that will work toward preserving the remnants of our wild life "as a part of our great museum of the out-of-doors."—Clyde Fisher.

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Series of illustrated lectures, held in the Auditorium of the Museum on alternate Thursday evenings in the fall and spring of the year, are open only to members and to those holding tickets given them by members.

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A room on the third floor of the Museum, equipped with every convenience for rest, reading, and correspondence, is set apart during Museum hours for the exclusive use of members. When visiting the Museum, members are also privileged to avail themselves of the services of an instructor for guidance.

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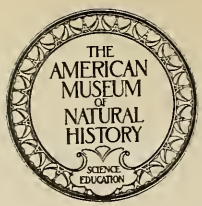

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EXPLORATION

FIFTY-EIGHT years of public and scientific service have won for the American Museum of Natural History a position of recognized importance in the educational and scientific life of the nation and in the progress of civilization throughout the world. With every passing year the influence of the Museum widens, as is witnessed by the increasing number of visitors who daily enter its halls. Nearly two and a half million persons visited the Museum for study and recreation during 1927, an increase of 15 per cent over the preceding year, and all of these had access to the exhibition halls without the pay ment of any admission fee whatever.

The Museum's service to the schools has been greatly increased by the opening, last year, of the new School Service Building. Ten million contacts were made during 1927 with boys and girls in the public schools of New York and the vicinity alone. Inquiries from all over the United States, and even from many foreign countries are constantly coming to the School Service Department. Information is supplied to, and thousands of lantern slides are prepared at cost for distant educational institutions, and the American Museum, because of this and other phases of its work, can properly be considered not a local, but a national—even an international—institution. Through its loan collections, or "traveling museums," which are circulated locally, 495 schools were reached last year, and 1,722,433 pupils were directly reached. Nearly a million lantern slides were lent to the New York City schools, and 3,301 reels of the Museum's motion pictures were shown in 122 public schools and other educational institutions in Greater New York, reaching 1,123,704 children.

Lecture courses, some exclusively for members of the Museum and their children, and others for schools, colleges, and the general public, are delivered both at the Museum and at outside educational institutions.

For those interested in scientific research or study on natural history subjects, the Library, containing 115,000 volumes, is available, and for the accommodation of those who wish to use this storehouse of knowledge, an attractive reading room is provided.

Many publications, both popular and scientific, come from the Museum Press, which is housed within the Museum itself. In addition to NATURAL HISTORY, the journal of the Museum, the popular publications include many handbooks, which deal with subjects illustrated by the collections, and guide leaflets, which describe individual exhibits or series of exhibits that are of especial interest or importance. These are all available at purely nominal cost to anyone who cares for them.

The scientific publications of the Museum, based on its explorations and the study of its collections, comprise the *Memoirs*, devoted to monographs requiring large or fine illustrations and exhaustive treatment: the *Bulletin*, issued in octavo form since 1881, dealing with the scientific activities of the departments, aside from Anthropology; the *Anthropological Papers*, which record the work of the Department of Anthropology; and *Novitates*, which are devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters. The Librarian of the Museum, who may be addressed in care of the Museum, may be called upon for detailed lists of both the popular and the scientific publications with their prices.

Expeditions from the American Museum are constantly in the field, gathering information in many odd corners of the world. During 1927 thirty-three expeditions visited scores of different spots in North, South, and Central America, Asia, Africa, and Polynesia, and nearly as many are now in the field continuing last year's work or beginning new studies.

From these adventuring scientists, as well as from other members of the Museum staff and from observers and scientists connected with other institutions, NATURAL HISTORY MAGAZINE obtains the articles that it publishes. Thus it is able to present to the constantly enlarging membership of the American Museum the most fascinating and dramatic of the facts that are being added to the Museum's knowledge, or are deposited in this great institution.

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MAY-JUNE
1928

The Journal of The American Museum of Natural History

HAWTHORNE DANIEL
Editor

A. KATHERINE BERGER
Associate Editor

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Photograph by F. A. Perret

INTERIOR OF THE GREAT CRATER OF VESUVIUS, SEPTEMBER, 1920

The 1906 eruption left a vast crater 720 meters in diameter by 700 meters deep. By 1920 the lavas erupted from the active conelet seen in the middle distance had filled the crater to within 200 meters of the top. As these liquid lavas spread over the surface of the basin, they cooled, forming a solid plug, except for the conduit connecting the conelet with the molten magna below. This building process goes on until another great eruption ends the cycle, when the process starts anew.

See page 302, "Volcanoes in Action"

VOLUME XXVIII

NATURAL HISTORY

NUMBER THREE

MAY-JUNE, 1928

THE WIZARD OF SUIYUAN

A Story of Sport and Travel on the Sino-Mongolian Frontier

By WILLIAM DOUGLAS BURDEN

Trustee and Research Associate in Herpetology, American Museum

IT was twilight as we shuffled up ankle-deep in the Chinese dust and stood under the grim battlements of the north gate of Gweihwachang, while a camel caravan from the endless solitudes of the Gobi sifted silently by and was swallowed up by the blackness of the arch.

There was something in the walls that stretched out massive and formidable against the evening sky, something in the character of the grand old watchtowers, something in their very atmosphere, that bespoke the lurking mystery of the frontier. Overhead, a rusted iron grating disclosed a grinning head that leered at us suggestively in token of the law of General Ma, Dutung of Suiyuan. A pigtail dangled idly between the bars of the cage. We passed on through the darkness of the arch and came at one step into a great city.

Without, there stretched a waste of desert, mountain, and plain, horizon upon horizon; within, was the hectic bustle of urban life. An immense volume of sound floated up with the dust and hung suspended over the low buildings—cries of shepherds, cracking of whips, the sharp shout of muleteers, the rumbling of studded wheels, the complaining shrieks of ungreased axles, the barking of dogs—all this filled the air with a constant roaring like the roaring of ocean waves.

It was the first night of the mid-autumn festival, a grand jamboree that penetrated every dark corner of the city, and, through this din and turmoil, a few quiet old musket-armed Mongols passed indifferently by, leading their shaggy-necked ponies down the dim alleyways. We threaded our way gingerly through narrow streets to the British-American Tobacco post. The Britisher in charge was in his cups. He had planted himself in the street and there stood gesticulating like a maniac, while a sea of yellow faces stared impassively out of the gloom. Chinese poured from his mouth as fluently as liquor had poured in. All traffic was blocked and the coolies waited patiently for this fit of foreign temperament to distil itself away. At our approach, the B. A. T. man, sighting foreigners for the first time in many moons, came out of his frenzy. To be alone with the Chinese, that was his lot and also his excuse for the bottle. After a few drinks, during

THE MOUNTAINS OF THE MOGOLIAN FRONTIER

In the distance may be seen the isolated mountains which are the home of *Ovis ammon commosa*. The evolution of this race is due to the fact that these mountains are cut off from the range of other wild sheep. Without isolation, subspecies will interbreed and soon will cease to exist. Thus isolation is necessary not only for the origin but for the maintenance of species, and it is therefore an essential factor in evolution

which our host gave us the gossip of the frontier, we went to an inn. Chu, my Chinese boy, served us supper. So here we were at last thrown back into ancient China,—a China that has been without apparent change for five thousand years. And beyond the walls of Gweihwa there stretched away under a starry sky the vast unknown spaces of Central Asia.

From the elevated plateau to the northward a pass tumbles down through the mountains to the plains of China. It is one of the great caravan routes between fertile China and the arid wastes beyond. In these mountains the bandits, the wolves, and the Mongolian argali make their homes side by side. The wolves and the bandits were not without interest, but it was the Mongolian argali—the great Asiatic sheep—that really occupied our thoughts. General McCoy, Major Magruder, Sears, and I pored over a map by candlelight, making our plans.

Next morning, on our way across the flats to the foothills, we met No-man-gin, the famous Mongol hunter of Suiyuan about whom we had heard in Peking. His eye was "stronger than the eagle's;" his knowledge of the sheep "an instinct." No-man-gin, one-time bandit, now large, fat, and prosperous, appraised us with glittering eye. Yes, for a mere dollar a day, he would find the great sheep. He led the way. We followed trustingly, while the old scoundrel plotted and planned and laughed up his sleeve at his gullible quarry.

In a few hours we were already in the hills. The north wind that came howling out of Mongolia brought with it the bitter cold of the Gobi Desert—a taste of the winter to come. We crossed a divide and dropped into the growing gloom that

seemed to hide a little mud village in the loneliness of those wind-swept mountains—just a cluster of huts surrounded by a compound wall—as if left there discarded on the barren flank of a gray hill. No-mangin ordered a family to vacate their dwelling in our favor. Docilely they obeyed, scurrying out with all their possessions. We tottered into the smelly darkness. It was damp and cold. A coolie was summoned to fire the "kang." He squatted on the dirt floor, feeding grass to a pathetic flame that needed constant attention. Except for a bit of joss-wood, the hills were utterly destitute of timber, so that grass and argol were the only fuels. The attempt to produce heat was a dismal failure. Volumes of smoke poured into the chamber. Half suffocated, we fled to the courtyard and there waited till the noxious clouds had trickled out through rents in the paper windows. So it is that the Chinese protect themselves against the ravages of winter.

After that, we bundled up in sheepskins, caught colds, and sat down by candlelight to a game of chess on an improvised board. A varied array of cartridges took the place of knights, bishops, and castles. Then we retired and tried to enjoy a little hard-earned rest. But the animals had something to say about that. The donkeys brayed incessantly. Dogs barked for hours on end, and conducted midnight fights up and down the courtyard. Cats squalled on the roof tops, and crawled through the paper windows into our sleeping quarters. Unearthly moanings sounded from adjoining rooms, through the long hours of the night. An attacked pig added his shrill squeals to the general disturbance, and now and then a wolf howl in the distance gave the village pack another chance to exercise its vocal chords.

TWO OF MY COMPANIONS ON THE HUNT

General McCoy (left), somewhat grizzled and gray but clear of eye, carried his years lightly, proving that they are but a trifling burden to a veteran campaigner in many lands. Major Magruder (right) has traveled north, south, east, and west, under the Dragon flag

THE HOME OF THE BANDITS, THE WOLVES, AND THE GREAT ASIATIC SHEEP
In the distance are the plains of China, which stretch away to the Yellow Sea. In the foreground is No-man-gin, the "Wizard of Suiyuan"

It is not in the nature of a Chinese to be in the least disturbed by braying donkeys, squalling cats, grunting pigs, unearthly moanings, and endless barking of dogs. He finds nothing in these sounds sufficient even to warrant comment, and therefore accepts them just as he accepts the filth of the courtyard that blows up into his face. We alone were the victims.

That was our first night in a Chinese village. Thirty more were to come, and they varied only in the quality of perfumes, quantity of noise, and degree of discomfort. Yet, though the pleasures of a roaring camp fire and the romance of camping in the wilderness were not ours, we were amply compensated by the privilege of viewing at first hand the age-old customs of the most ancient civilization in the world.

The next morning we headed back deeper into the hills. That canny old rascal, No-man-gin, wanted to bait us, to raise our hopes, to whet our desires by giving us a glimpse of the great sheep. That, he thought, would satisfy us for awhile, and delude us into thinking that we were in good country. Failure would then untie our purse strings, and when the reward on a good head reached a really desirable figure, the old Mongol would then turn the trick in a day or two.

Such was No-man-gin's understanding of the white man. To that extent were we mere pawns in his hands, whom he could move at random through a maze of intricate mountains with the finesse of a master. He took us to a "passing ground," a place sheep frequently cross on their travels from one range to another, a spot where you can see them occasionally as they restlessly pass by, but where you can seldom make an effective stalk. No-man-gin knew the spot exactly. He told us all to be very quiet while he slipped up to a shoulder of rock at the bottom of the

cañon. Then he waved to us, and we passed out around the bend. Suddenly No-man-gin pointed. A great solitary ram had mysteriously appeared on the rim wall a thousand feet above us. His strong shoulders, proud neck, and thick-set, curling horns were silhouetted against the sky. In that one picture I seemed to see the very soul of the Mongolian argali. As he stood there, a chiseled image on the sky line, I could well understand why *Ovis ammon* has been so often described as the grandest of all big game.

Sears and the General made a short stalk. A couple of shots echoed up and down the cañon, and Mr. Ram leaped away unscathed.

After that we had a week of futile hunting, that consisted of long, hard, blank days in which sheep were seldom even sighted. Major Magruder had the luck to bag a beautiful goral, (a species of goat-antelope, *Nemorhædus goral*), and the General secured an Asiatic roe deer. These last were as wary as they were plentiful, and therefore offered excellent sport. As to the sheep, we grew daily more impatient. The General stayed out every night until it was pitch dark. Sears, ever restless on the trail, fretted and worried himself half to death over our ill luck, and I covered country as fast as my legs would carry me, while Magruder philosophized on the beauty of the mountains, and No-man-gin giggled up his sleeve.

At the end of ten long days we headed off for Dung Wushitu (East-West Village), the home of No-man-gin at the base of the mountains. I am still calling them mountains, but actually they are not. To a physiographer, the formation is that of a cuesta with insequent rivers that have eaten back into the nearly horizontal strata of the cuesta scarp, carving out of it a series of complex winding cañons. Dung Wushitu is situated at the mouth of one of these cañons, where it debouches

ON THE TRAIL
The ever faithful "Chu" in the lead. Load a donkey to the "brim" and there is always room left for a Chinaman on top

A CHINESE MOUNTAIN VILLAGE AT WHICH WE STOPPED

Every night the courtyard was filled with camel caravans, goats, pigs, cattle, and dogs, and the million and one strange sounds which resulted from this conglomeration of beasts. Every day we saw the life of the great Pass. Mongols shuffled by on tireless shaggy-haired ponies. Endless trains of camels moved off silently on soft, rubber-like pads

from the escarpment face on to the plains of China. It was distant fifty li—about seventeen miles—so, having ascertained its general direction, I started off without a guide, as I was determined to give myself the pleasure of hunting alone.

I said good-bye to the others at an early hour. A strong wind was blowing out of the northwest and, during the night, ice had formed in all the little patches of quiet water in the stream bed. For about four miles I struck out over the ridges to some good roe deer ground. The country was rough and rocky. I crawled around among the miniature ravines, peeping over wind-torn ledges, peering into purple gorges where the roe hopped nimbly out of view. I saw many of these graceful, shy little creatures, but they were all does. Then I had luncheon behind a sheltering rock. The upland was a partially dissected plain. There was a perfect accordance of summit levels, and it was wonderful to note the symmetry of stream erosion in the sedimentary strata. The regular diversity in the forms and shapes of the terrain, along with the shadows that brought them into relief, and the colors that painted them, were a constant source of pleasure to the eye. Erosion here was in a youthful stage. The greater part of the landmass was still upland.

I felt lazy after my full meal and nearly dozed off to sleep, utterly unapprehensive of the struggle that lay ahead. All the others had gone on to Dung Wushitu, but, after all, what was the hurry, so long as the sun continued to shine and soak into my bones? After a while I began nosing around again among the little ridges, using my field glasses frequently and keeping a constant lookout. I saw several red foxes, which I watched at my leisure, to see if I could gain any points

in the art of stalking. Also, I observed a wild cat among the rocks and a few marmots. The skins of these animals may be obtained in Peking for a mere pittance and made up into the most beautiful coats.

Finally, I jumped a buck, but he was too quick, and disappeared from view in two flying leaps that hardly gave me time to pull the trigger. He had been lying down, concealed in some heavy grass, and had therefore escaped my vigilance.

Late in the afternoon, I descended into the gloom of the deep cañon beneath. The skies had suddenly become overcast. By the time I had scrambled down into the bottom of this dreary gorge, night shadows were already sweeping over the sky. So there I was, with some thirty-five or forty li ahead of me, and no moon to light the way.

"Stupid fool," I thought to myself, "you'll have to pay for your day-dreaming, now."

In less than an hour the night was inky black, and I found myself stumbling painfully down that bowlder-strewn gorge, the narrow walls of which soared up almost vertically for more than six hundred feet. Gusts of wind swept down the cañon. It was a cold wind, that came from the lonely distances behind. The river was roaring in my ears, an everlasting, ominous sound that seemed to add confusion to the darkness. As I looked aloft, I could see a dim gray light, and the vague outlines of heavy clouds streaming by on their way to Dung Wushitu. Beneath that dim grayness was a deep pit of solid black with sharp, invisible rocks and tumultuous snarling waters. It was as though I were in a dream, following the sacred river through "caverns measureless to man." And then, as I

COOLIES BEFORE A HOUSE AT WHICH WE STOPPED

A foreigner finds it a little difficult to accustom himself to some of the habits of Chinese coolies. They are past masters, for example, at making the most disagreeable sounds imaginable, and handkerchiefs, of course, do not exist

TAKING TIFFIN EN ROUTE TO JIRGO
Such narrow valleys as these offer the bandits all that is necessary for a successful surprise attack

fell again, and cursed, and failed even in the satisfaction of hearing my own curses, I thought "What a likely lair for brigands." The cañon zigzagged in sharp, angular turns, back and forth, back and forth, everlastingly. I was constantly wading and rewading the ice-cold stream. Due to the violence of the torrent, the slipperiness of the slimy rocks, and the blackness that I had to push against, there was a certain hazard to this journey. Had there been any timber, I would have built a fire and camped out quite comfortably for the night. But there wasn't, so I just felt my way along, stubbing my toes sullenly, stumbling and falling until bone and flesh were bruised and bleeding. "The thousand natural shocks that flesh is heir to—" I kept thinking.

Finally, my Chinese felt slippers, which I had been wearing in the hills for comfort, gave way completely under the strain. Nails bit through the bottom into my feet, and the slippers themselves became so like wet paper that they lost all shape and kept coming off. After several prolonged searches for them in the darkness, I tied them on with some rope. This held them properly, but they were so soft that they offered no protection against the rocks. At last, in some distress, I stopped, put on my Alaskan parka, and sat down. Small comfort in this, however!

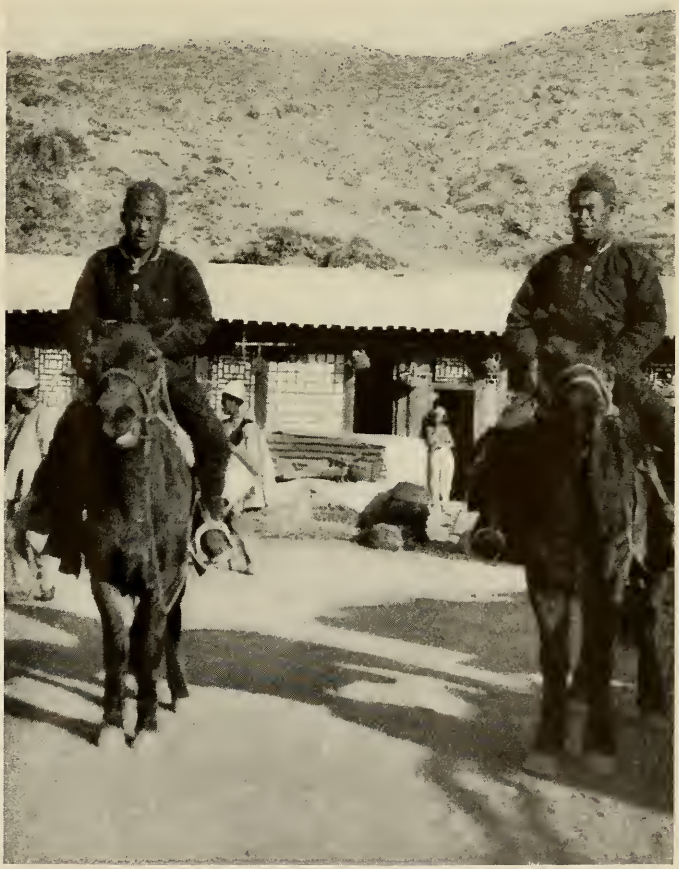
The cañon to me was *terra incognita*. I knew it led to China, but no more. The wind was increasing. The frost was biting harder. This was a poor place for tired muscles to rest.

I have often traveled alone, and usually I like it, but not this time. "A dismal place," I thought, "this cañon on the Sino-Mongolian frontier." While meditating thus, I ate what remained of my emergency rations. Then I stumbled on again, not for minutes, but for hours, while the cañon seemed to sink deeper into the earth, so that even the friendly sky overhead became no more than a

thin ribbon of gloomy gray, as distant as the stars. Then, suddenly, the walls of rock broke in front of me, and that seemingly subterranean river which had been fighting savagely with its hidden banks, swished out under a broad open sky, and went whispering away into the distance over the plains of China. Broad spaces stretched on every side. I couldn't see them but I could feel them. It was like coming out of the shaft of a mine at night. The wind behind me howled among the mountain-tops. That, and a gentle whispering of waters was the only sound. I felt very lonely as I stood there and listened and debated what to do next. Then I sat down again.

Suddenly, I heard a dog bark—sharp, staccato yelps, that came like calls of welcome out of the night. I steered for the sound, nearly stepping over a river terrace bank perhaps twenty feet high, on the way. Finally, I found myself against the outer wall of a Chinese compound. A little boy was singing in the courtyard behind the wall. I called out. The singing stopped. The barking began again furiously. The boy appeared bearing a light. He held it close to my face, and then ushered me inside. What a pleasure it was to get into a warm, lighted room!

There were about ten people sitting on the heated "kang." It was a typical Chinese peasant family. A dried-up old woman, her face furrowed with lines and creases, gave me some tea, and some dry food that reminded me of dog biscuits, and required strong teeth. After that, attempts at conversation produced no end of laughter on both sides. I drew maps, I waved, I gesticulated, I tried everything that ingenuity could suggest. They couldn't and wouldn't understand. Finally, I brought out a large, fat, shiny Yuan shi Kai silver dollar, and placed it conspicuously on the table, under the candlelight. Its radiating silvery glint would, I felt sure, increase their understanding. It did, with the result that after half an hour I succeeded in conveying the idea that whoever would lead me at once



OUR BODYGUARD

General Ma, Dutung of Suiyuan, with the power of life and death over several million people, was solicitous of our welfare. The bodyguard, seen above, arrayed in the Dutung's own colors, was therefore sent to protect us

THE HUNTING COUNTRY ON THE MONGOLIAN BORDER
A windy rift where the first shot was fired

to the "datien" or inn at Dung Wushitu would be the recipient of that beautiful coin. Some lanterns were lighted and I set out again with a noble escort of two Chinese boys. I had no idea how far we had to go, but luck was with me. It was a bare two miles. As we came into the village, the wild, half-starved Chinese dogs displayed their customary animosity in a villainous fashion, and almost attacked us. We kept them off with stones. Then, finally, as I stepped in among friends and received all the kind attentions which the faithful Chu knew so well how to administer, and the brandy had had time to send a warm glow radiating to my very finger tips, I could but mutter, "General, ain't it a grand and glorious feelin'!"

The next day General McCoy and the Major had to leave for Peking. Very sorry we were to have them go and they sorry to leave. Grand sportsmen both. Thus Sears and I were left alone to the wiles of No-man-gin, who knew full well that as soon as we shot a good ram or two we would probably pack up and leave. His aim, of course, was to detain us as long as possible. We therefore took the matter in our own hands and determined to go through to Jirgo, distant about ninety li, where we knew some big rams had been seen the year before. Until the true situation dawned on us, we had been completely at the mercy of the old man. He could stand up under a rain of questions, answering whatever was his pleasure—lying whenever a lie was to his advantage—with the greatest equanimity. We had many interviews, all of which availed us nothing. And, at the end, Chu, who had acted as interpreter, would say:

"Please, Masta, I tink it No-man-gin tell velly big lie."

We therefore ignored the ex-bandit's advice, and made our own plans. While we were getting our outfit started on "the long white trail" that winds up the escarpment of the cuesta, an old Mongol rolled into Dung Wushitu with such

stories of bandits that our muleteers simply unloaded the packs and refused to go.

Now at last, Sears and I thought to ourselves, we may catch a glimpse of these famous bandits. Even in Peking, everyone had been talking of "our dangerous undertaking," of "the bandit-infested mountains," etc. We had not even been able to secure the usual passports, so at last in desperation we simply left with nothing but "hoojows," or rifle permits. Then, again, at Fengtien, where we spent the first night on a station platform, there had been endless talk of Hunghutze. Always it was Hunghutze this, and Hunghutze that. Always the bandits seemed to be just ahead, like a shadow on the trail. Now the Dutung saw fit to force a guard upon us. The guard consisted of two perfectly nice soldiers dressed in black. Of course, if any bandits had appeared on the most remote skyline, our distinguished guard would have run like frightened rabbits. Moreover, they did not calculate to impede their possible flight with heavy rifles, and therefore left them behind. But even though our escort was utterly useless, it was necessary to pay them "tea-money." We did not fret much, however, over the additional expense, for we were traveling at less than two dollars gold, a piece, per day.

But to get back to the muleteers. They, having cast off the loads, now disappeared in the byways of Dung Wushitu. As soon as they had sidled away, we summoned No-man-gin, and gave him his orders: "We start immediately." He was to recall the muleteers.

No-man-gin now revealed himself as the bully of his village. The natives, probably fearing lest he return to his former occupation and desiring, therefore,

THE FIRST RAM

Throughout the entire hunt I saw only fifty sheep, and the greater number of these were ewes and lambs. Only five good rams were seen by the party. Now that the rail to Gweihwa offers foreigners easy access to the mountains, the toll on the sheep will be increasingly severe. Since there is no escape from these isolated mountains, there is every indication that this race of sheep is doomed to extinction

A STOP FOR A SMOKE

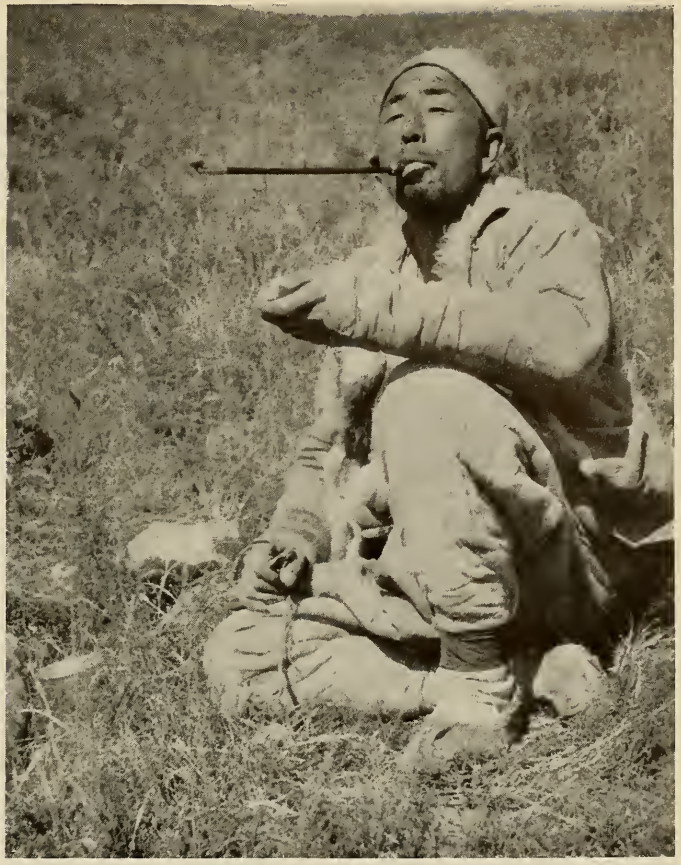
A wee nip of tobacco fills the pipe, a fight to coax a spark from a piece of flint follows, then three glorious lungfulls, much slobbering and sucking to indicate the satisfaction derived, and we are off again on the trail of the Mongolian argali

to keep in his good graces, treated him with the respect that becomes a Mongol bandit. In Dung Wushitu, No-man-gin's word was law. Now he sat himself down comfortably and let it be known that the muleteers were to return at once. In a few minutes they came scurrying back from every quarter, looking very dejected and sorry for themselves. Soon afterward we were off, headed for Jirgo, a little town, which, report had it, was being attacked by bandits. It was said that part of the town had been burned and many people killed.

Sears was particularly pleased at the prospect of an adventure. The sheep hadn't given him much excitement, so now he was counting on the bandits. For thirty miles we struggled through the mountains. Just before dark we crossed a divide, and looked down into a broad, brown valley that yawned before us. We could just see Jirgo at the bottom of the hollow —a few huts, like raised scars on the landscape, and many little black holes which were doorways to the dugout dwellings in the steep banks of loess. It was dark when we arrived. The bandits had been dispersed, and Sears was woefully disappointed. The village life seemed to be going on as though nothing had happened. But several men had been wounded, and these uncared-for wretches were suffering tortures. One villager was mortally wounded, bullets having raked his body through and through. I gave him a cathartic, an iodine solution for his wounds, and some morphine to make him more comfortable. In a few hours he was clamoring for more.

The day after our arrival was "lucky day." Weddings and funerals alike had been saved up for this festive occasion. Imagine a broad, lonely valley, away up there on the border of Mongolia. Imagine a sprinkling of mud huts and dugout holes in the loess, like bank beaver burrows. Then picture a barbaric, brightly colored procession, fluting and trumpeting up and down the only street. Mother and father stand in their separate doorways,

kotowing solemnly to the groom, who struts proudly by, while the bride, hidden beauty, swings serenely in a chair on the backs of coolies. But she is not quite as sedate as one might suppose, for she is constantly seen peeking out from between the gorgeously colored curtains that surround her —first on one side and then on the other. The village being very small, one such display is considered insufficient, so they trail out into the fields beyond, where, with great difficulty and much talk and laughter, they reorganize and march ceremoniously up the same street again. This maneuver is executed no less than three times.



AN EX-BANDIT OF THE MOUNTAINS WHO ACTED AS OUR GUIDE
Small wonder he wears such a bland, wholly self-satisfied expression, for my luncheon, which had been given to him to carry, had mysteriously disappeared. But, of course, he did not understand that it was *my* luncheon. Oh no! He was quite beyond guilt

The hunting in the neighborhood of Jirgo was very disappointing; in three days I saw one ewe and of her I caught only a glimpse. We began to think of *Ovis ammon commosa* as no more than shadowy phantoms that disappeared over sky lines, to be gone forever. The next day, therefore, we headed out again into new country.

Two long days in the hills followed, during which I saw plenty of tracks of all kinds of game, including wolves, but that was all—only tracks. After having tried so hard and so long and obtained nothing (not even a shot) I vowed that evening to stay until I got a ram. So Sears and I went separate ways. I moved on down the range, and Sears went to Gweihwa, with the idea of going on to Pauto, the end of the trail, the jumping-off place for the wapiti country, and, incidentally, the Mecca of opium smuggling. By the time I reached Lama Tang and got established in a temple surrounded by sneezing and coughing goats, it was too late to hunt. That night I succumbed to No-man-gin. I counted out seven silver dollars under his nose. They were to be his as soon as I obtained a good ram. The next day No-man-gin was a wizard on the trail.

First, we climbed for two hours, stopping frequently for a short breathing spell and a look back to the plains of China, which stretched away endlessly to the Yellow Sea.

THE WRITER ENJOYING THE COMFORTS OF MONGOL DRESS
For less than four dollars all this furry warmth was purchased. A piece of rope around the waist to take the place of a belt, and I was virtually insulated against the cold winds of the Gobi

Suddenly No-man-gin saw a fresh ram track. He studied it critically. Then, without comment, he continued for another hour. At last he crept up on all fours to a ledge of rock that dropped away in front of us to a large, semicircular basin. He was extremely careful not to make the slightest movement on the sky line. Obviously he expected to see something. We looked, but nothing stirred in that whole valley. It was empty and still. No-man-gin, quite undaunted, prepared himself comfortably for a long wait. "Laziness," I thought to myself, but I was wrong, for although all the valleys looked alike, No-man-gin knew with apparent certainty that the ram had selected this particular one. After half an hour had slipped by I was decidedly chilled, and thought it high time to be on the move, and I said so. But No-man-gin refused to budge. He continued to lie there motionless on one elbow like Sohrab on the sand, his eyes searching out every last clump of grass. Suddenly he nudged me and pointed. I looked hard. At last, away off in the bottom of the basin, about four miles away, I made out a tiny speck. When the speck ceased to move, I lost it again.

"That is the ram," said No-man-gin.

I picked him up with my field glasses, and saw, to my joy, a beautiful heavy set of curling horns. One glimpse was enough. We were off. In order to effect an approach unseen, a long detour down into the bottom of a cañon was essential.

As we approached the spot after about four hours of hiking, six ewes suddenly appeared on the sky line. They moved out of sight, not much disturbed. We followed to the crest and watched them for about twenty minutes. There were two rams with them too small to warrant shooting. Several times they changed ground, and we changed accordingly, always keeping above them. All the

sheep were quite a distance off, so I had my three-hundred-yard sight up.

Suddenly, No-man-gin, who had wormed his way up to the very edge of the rocky bluff on which we were lying, waved to me frantically. I crawled up just in time to see a grand old ram walking almost directly beneath me, and about to disappear from view under an overhanging ledge. I fired quickly, aiming a little low; but I had failed to put down my three-hundred-yard sight, so the bullet struck the ground just over his back. In a second he was down the ravine and out of sight. I ran to a point of vantage and fired at him as he and two ewes raced up the opposite slope. No-man-gin all this time was nudging me in the elbow, and urging me to shoot. I saw my second and third bullets bite the steep, dusty slope, one just over him, the other just ahead. When I fired my fourth shot, he was within fifteen yards of the top, and about to disappear forever. I never saw where the bullet struck, but, as I was slipping in another cartridge, he stumbled, reared up, and fell headlong down the ravine.

Then we just gave way to exclamations of joy. For a Mongol, old No-man-gin was really excited. Was he happy over my success, or was he thinking of the seven silver dollars? The kick of the gun gave me a violent nosebleed, which the old man clumsily tried to stop with his fingers. But nothing mattered. I was jubilant. All the long weeks of steady hunting without a single shot were rewarded.

The following day Sears, who had by this time returned from Gweihwa, hunted with No-man-gin. He also baited the old scoundrel with seven gleaming dollars. The effect was magical. Late that night he stumbled into the temple with as fine a sheep head as ever I hope to see, the third largest, according to records, that has been taken out of the country.

WELL PADDED AGAINST THE COLD

The Chinese children, unlike ours, learn at a very early age to shoulder the responsibilities of the household

Thus in two days No-man-gin, when the lure was sufficiently attractive to engage his serious attention, demonstrated his ability as the most uncanny and remarkable sheep hunter it has ever been my fortune to know. In each case he accomplished his purpose within twenty-four hours from the time that the bait was dangled before him. So much for No-man-gin, the wizard of Suiyuan. He is an artist whose maneuverings it was a privilege to witness. May others have as much pleasure contending with his ingenuity!

Ovis ammon commosa

Are these sheep dying out? Will they be exterminated? These are questions one is often asked.

They inhabit a range of mountains from which there is little or no opportunity for them to escape. Native hunters are constantly looking for fresh mutton, and now that the railroad has pushed through to Gweihwa, thus offering easy access to the mountains for foreigners with foreign rifles, it looks as though the toll on the sheep would be increasingly severe. Of course there are no game laws, and there probably never will be, for game laws are an unheard-of thing in China. There is every indication, therefore, that this particular species of sheep, *Ovis ammon commosa*, (formerly *Ovis ammon jubata*) is doomed to extinction. It is simply one of many thousands of species which the white man, the greatest killer the world has ever known, will succeed in exterminating.

I have referred elsewhere to "this isolated set of mountains." Here is an excellent example of the importance of isolation in the origin of species. It is well known that isolation in one form or another is an essential requirement for the production of new species, and, furthermore, that the degree of specialization in a given genus necessarily depends to a large extent on the degree of difference between the specific habitats. Environment as a selective factor in evolution is well established, and it therefore becomes apparent that the amount of difference in the environment, in part, at least, controls the degree of specialization. If subspecies were allowed to interbreed, the subspecies would be abolished. Their very existence depends on isolation, which is therefore necessary, not only for the origin but for the maintenance of species, and is therefore an essential factor in evolution.

A MONGOL VILLAGE SOUTHEAST OF THE GOBI DESERT

A Tray for Carrying food

THE BUSH NEGROES OF DUTCH GUIANA

How a Slave Rebellion of Two Hundred Years Ago Freed the African Natives Who Had Been Transported to Serve the Dutch Sugar Planters, and How These Transplanted Free Black Men, Living in the Jungle, Have Carried on the Traditions of Their African Forebears

By MORTON C. KAHN
Cornell University Medical College, New York City

NEAR the northeastern coast of South America, more precisely in the hinterland of Dutch Guiana, there is a unique civilization little known to the white men of this continent. We know much of the strange life of the Congo and of the fascinating customs peculiar to the inhabitants of the African jungle, for a number of explorers have brought from the Eastern tropics the interesting accounts of their experiences. But of the Surinam Bush Negro, Djuka, as he calls himself, who nearly two hundred years ago fought his way from slavery and has since maintained his independence, of the survival of his African customs and craftsmanship, of his medicine and religion, little has been told.

Beginning in the early part of the seventeenth and eighteenth centuries, the Dutch colonial planters cultivated large sugar plantations on the banks of the Lower Surinam and Saramacca rivers in Dutch Guiana. In those days the labor problem was easy: as was the common practice, the planters obtained natives from the West African Coast and compelled the men and women to work as slaves on their plantations. It is of the descendants of some of these African slaves that I write.

In 1750, or thereabouts, a few slaves of the outlying plantations rebelled against their white masters and escaped into the jungle. Others soon reinforced them until their numbers became very formidable indeed. After a series of long and bloody wars, aided by the impenetrable South American jungle, their own bravery, and the sagacity of their leaders, the escaped

THE FIRST GLIMPSE OF A BUSH NEGRO VILLAGE ON THE UPPER SURINAM

The Djuka settlements are situated in the dense jungle on either bank of the river, at intervals of from a half mile to several miles, and ordinarily some distance from the river bank outside the range of any possible inundation. Very often, too, they lie in close proximity to water falls which form some barrier to possible invaders

Negroes gained many victories over the combined forces of the Dutch and British allies. The wise colonial authorities, seeing that any further attempt at recapture was futile, made a truce, and though the attacks upon the Negroes kept up spasmodically for many years, the blacks retaliating by making vicious forays against the outlying plantations, it was finally agreed by both sides to have peace, and complete freedom was granted to the slaves who had escaped.

From that time until the present, the descendants of the revolutionary slaves have remained a free and independent people. Today they live a peaceful, contented, and primitive life in their little villages of thatched huts in the jungles which border the middle and upper Surinam, Marowyne, and Saramacca rivers, and certain tributaries of these great streams.

The Negroes of North America, as well as those of the West Indies and other territories in this hemisphere, have cast off nearly all of their African heritage, completely yielding to the influence of white civilization, eager to immitate its customs and to emulate its standards.

The Djukas are of an entirely different mold. They still cling to a number of the African customs and crafts of their revolutionary forefathers. Many of the slaves who rebelled were born in the colony. On the other hand, the rebel forces contained a goodly sprinkling of recent arrivals from Africa, and although these slaves came from many different tribes, a number of customs and traditions were held in common. Under the patronage of their dusky leaders, the culture of the black men was welded and cherished and that of the white man deemed deeply inferior. This idea, in a modified way, holds even

at the present time. To the Bush Negroes the white man is not a superior being. They realize that *"buckra obeiah bon"* (white man's magic is good), but they are proud of their own, which seems to suit them much better. In a word, they have absolutely no sense of inferiority. On the other hand, many of the Djukas tend to regard the white man as a weaker creature. The Bush Negro's ability to take care of himself under jungle conditions is apt to make him look down on the white man, who is, in truth, at times relatively helpless without the Djuka's aid as paddler, hunter, or guide. On many of the rivers no progress into the interior can be made without their help.

The Djuka finds his own living. Game, fish, oil-bearing nuts, and a little fruit are furnished by the jungle; the land is fertile and, although a terrific battle must be constantly waged to keep out the ever encroaching jungle, as well as insect and bird pests, each village has its little provision ground, which furnishes cassava, yams, peanuts, and occasionally sugar cane and peppers. Curiously, the provision clearing is always situated at quite a distance from the village. Upon inquiring the reason for this, I was told that the custom of having the provision clearing so placed was a survival of the days of the rebellion for, when the white forces discovered a rebel village, it was usually destroyed, but the wily blacks would retire deeper into the forest, far beyond their provision ground, where they would rest in safety, and occasionally send scouts to the clearing for food.

Traders from the Dutch towns come up to the more accessible Bush Negro villages and barter for the hard-wood timber which some of the Djukas cut. While the necessities of these people are never controlled by the whites, the lumber, or the money paid for it, forms a means by which

A FAMILY GROUP—LOWER SARAMACCA RIVER
Very characteristically they wear amulets around their necks, designed to ward off some evil or to insure good fortune

THE APENTI OR SIGNAL DRUM—UPPER SURINAM RIVER
The design *motifs* are those of the snake and the notch. The snake *motif* is practically identical with a similar *motif* often occurring in the work of the West African natives

they can purchase shotguns, brightly colored cloth, brass wire coils, and tobacco. They also barter for axes, shot, powder, knives and other iron ware; for, while the Bush Negro deems it a disgrace to bring anything into the village that can be made by him, he is not averse to trading for the articles mentioned above. The bright cloth is used for raiment that is worn as a sort of toga. People clothed in this manner are to be found in many parts of the West African Coast. The brass wire coils are used for ornamentation, especially by the women, and are wound tightly about their arms and legs, a custom distinctly African in its origin. Far up the rivers, however, are communities few occupants of which ever come into contact with white men.

Their method of using tobacco is unique to say the least. Instead of smoking as we do, most of them prefer to suck up through their broad nostrils a dark brown fluid made by soaking the tobacco leaf in water, to which a little wood ash has been added. They offer to their guests a small vessel containing this liquid, as we would a package of cigarettes. The noise emanating from such a gathering is great, and I often wondered how the membranes of their noses and throats withstood the constant application of the burning substance.

Besides the protection given them by nature, the Djukas' feeling of superiority is based upon a word of mouth record of their successful war for freedom. This has been maintained from generation to generation in a sort of saga in which the names of the leaders, the stories of the battles, the anecdotes of magic protection against white man's bullets, and the instances of individual heroism and cleverness have been preserved. The history is told in a literary or ceremonial language, which, so I am told, is composed largely of modified African words. It is noble speech, or "deepee talkee" (deep talk) and unintelligible to others than the Bush Negro. The cook on my little expedition, a Negro from the Dutch town, was entirely

unable to understand it. The common speech of the Bush Negro is "talkee talkee." This is spoken by all of the natives of Dutch Guiana save the aboriginal Indians, and even by some of them. It is a mixture of Dutch, French, English, and African words, with a dash of Portuguese for good measure.

Curiously, upon constant inquiry, I was surprised to learn that the Djukas have no memory or cognizance of Africa; their history, as far as they are concerned, dates from the rebellion, and they have no knowledge of their origin prior to that time. My chief paddler, Quacoe, had an African name of important significance. Although he was doubtless named in honor of the famous Bush Negro rebel chief, the name was originally that of a king of the Ashanti people on the West African Coast.

Another remnant of culture strongly suggestive of the dark continent is the highly developed system of drum telegraphy found among the Surinam River Djukas. Besides the call "white man comes," I have heard others which were interpreted to me as "come quick, sick" "call the Gran Man" (captain) "come to the meeting," etc. Some of the natives use the drum upon which to talk to their "Gran Gadu" (great spirit), feeling that the throbs of the instrument are more likely to reach their celestial destinations than mere words or thoughts. News of one's arrival is anticipated in the same way by this tom-tom code, and if the visitor has made a bad impression, this negative report is well known up the river. In this case the blacks will refuse to trade or assist the offender, and uncomfortable indeed is the plight of one so greeted.

In many parts of Africa one finds the

ELABORATELY CARVED WOODEN STIRRING PADDLES
Like every other implement or utensil in constant use, these food paddles are decorated with the traditional patterns

FASHIONS IN COSTUME ON THE MIDDLE SURINAM
The cloth of which these highly original garments are made comes through traders who operate along the rivers

curious custom of skin decoration by cicatrization. This practice is found widespread among the Djukas. A number of incisions are made into the flesh of the face, arm, back, thigh, or abdomen, with a sharp knife, and into these cuts finely ground charcoal is rubbed. The wounds are arranged so as to form a design of geometrical proportions and, when healing is completed, these form a pattern of scar tissue welts. This custom of decoration is common among the women, and few have any claim to beauty without a pattern cut at one place or another upon their anatomy.

The Bush Negroes in the upper reaches of the rivers are deathly afraid of the French incorrigibles, and justly so; for these convicts, who escape from time to time from the penal colonies in adjacent French Guiana, in their desperate attempt to gain freedom by the overland routes through the forest, have, so I am told, attacked Djuka villages, murdered men, ravaged native women, and stolen provisions, thus making themselves formidable enemies of the black men. It is said to be the custom among the more remote villages to shoot these convicts on sight when encountered, and many harrowing tales seep down from the far interior, of fierce and bloody pitched battles fought in the eternal twilight of the jungle or along the swift streams, for the Djuka first and last protects his own.

The artcraft of the Bush Negroes is by far the most outstanding of their many interesting characteristics, and certainly makes an indelible impression. As far as my limited experience will allow, I must say that I do not know of any existing aboriginal people in the Western Hemisphere in whom the artistic impulse is more highly developed, or among whom artistic ability and attainment play a more important part in the social structure. While collecting specimens of their wood carvings for the American Museum of Natural History, I found that they were not at all anxious to part with these implements, and finally traded with me only because I offered an exceptional inducement, and because my guide explained that

I had come a long way and that the products of their craft were to be greatly admired.

On the middle and lower Surinam River I found that money and leaf tobacco were the chief means by which trade could be effected, but as I journeyed farther back into the interior on the Surinam, the value of the "guilder" decreased and that of tobacco increased until, finally, in the more remote villages, toward the end of my trip, the leaf was the sole means by which any trading could be done. After many unsuccessful attempts, I finally secured the most highly prized of all of their possessions, the elaborately carved telegraph drum or apenté, and then only because its owner had been lately ostracized from his village and traded with me for provisions. However, one young lady voluntarily gave me a bracelet of delicately filed iron because, as she claimed, my eyes put her in mind of those of her husband, lately deceased, so it may be inferred from this incident that sentiment is not entirely absent among them.

The man who is able to carve in wood artistically is looked upon with high favor by the women of the tribe and is also respected by members of his own sex. Of course, the ability to hunt, fish, and successfully provide for a family are qualities essential in every young man seeking a mate, but these are widespread and almost taken for granted, for there are few Bush Negroes who cannot hold their own on the game trails or along the swift rivers.

By the same token, many of the men are able to make these wonderfully artistic wood carvings, and the women seem to require that their households be provided with implements of a highly decorated nature. Sloppy or careless artistry is, so I am told, taken as additional grounds for divorce (a divorce being easily acquired by women in any event).

Thus the Djuka men decorate practically every implement which is used in the daily life of the tribe. Small wooden paddles made simply for stirring cooking food, are, as may be seen from the accom-

AN AID TO BUSY MOTHERS

The baby is carried on the mother's back, face forward, with feet straddling her waist, and is held firmly in position by a wide band of cloth tied around her body

CLEARING IN A BUSH NEGRO VILLAGE—UPPER SURINAM
The four-walled huts, with low, overhanging, thatched roofs that successfully shed the heavy tropical rains, surround the clearing, though in no fixed positions

panying illustrations, highly and artistically carved in one or more of the traditional designs. Graceful canoe paddles, especially those which are used by the women, are similarly decorated. The low stools and benches upon which the natives sit truly call for superb efforts on the part of the wood-carving artist. Combs used for combing their kinky hair, which are not even worn as ornaments, the small, low tabourettes which serve at times as tables, the calabash gourds which are used for plates and spoons, are always splendidly decorated, delicately and symmetrically designed.

Experienced ethnologists who have made a special study of Negro art—Gerhardt Linbloom, and others—have arrived at the conclusion that this art work and the *motif* displayed, though now modified to some degree, are very probably a survival of the African heritage.

Linbloom states that the snake *motif* shown so often in Djuka carvings is very closely related to designs of the same character found among the tribes of African Guinea and Dahomey. Other units of decoration he has been able to trace to the Ashanti and Benin people. The wooden combs, with their gracefully pierced ornamental work, are an almost unaltered remnant of African origin, as they are being made and used today by the Negro tribes in the northern part of the Ivory Coast Colony and other regions of Africa as well. Specimens of these combs taken from many parts of Africa may be found in the collections displayed at the American Museum but, curiously, they are not as delicately wrought nor as symmetrically carved as are those made by the Djuka artist in the South American jungle, four thousand miles and two hundred years away from his fatherland.

Many other instances could be given to show how closely related to West African art is that of the Bush Negro, especially to that found on the Gold and Slave coasts and in the Cameroon. The districts mentioned are among those from which

large numbers of blacks were shipped to the Americas and in all probability the similarities are not accidental. Further, the snake designs which occur so often are religiously emblematic for the Bush Negro and likewise in West Africa, where at Dahomey and Whydah, whence came so many thousands of slaves, snake worship has one of its principal centers.

When one considers that the tools used by the Djuka wood carver are cheap trade knives and dividers, and that the smooth finish is usually accomplished by the use of a mat of grass dipped in fine river sand, one cannot help but be amazed at the beauty of the workmanship.

If space permitted, many interesting things could be told of the rebellion, and of the religion, medicine, and government of these people; how they believe in a supreme God, a ruling spirit over all things but, besides, have a number of minor deities such as the alligator, silk-cotton tree, and a type of boa constrictor that accompanies their voodoo ceremonies; how they allow their dead to remain for days in the tropical heat before burial. Much could be said of their obeiah priests and witch doctors, of their famous snake-bite cure made from the roasted head and tail of a venomous snake. This concoction is highly prized even in Dutch towns and is believed by many also to have the power to turn poisonous reptiles from one's path.

Then there is the sacred medicine city of Dahomey (pronounced "Daumay") far up the Surinam River. White men are not permitted to enter it, for it is thought that the god who hovers over this sacred precinct would be offended at their presence. Here the seriously ill are brought from near-by villages and ministered to by special witch doctors. It is said that miraculous cures are often effected.

One cannot close without a word concerning the benevolent rule of the highly

BUSH NEGRO MAN OF THE LOWER SARAMACCA RIVER

He wears the abbreviated toga-like garment which is put on only when strangers are present or when he is visiting an alien village. This upper drapery, which is also worn for ceremonial occasions, is usually a patchwork of brightly colored pieces of cloth covering the right shoulder and leaving the left shoulder bare. Ordinarily, his only clothing is a breechcloth held in place by a string around the waist

A WITCH DOCTOR'S HOUSE—UPPER SURINAM RIVER
Medicine and its ceremonial accompaniments are the prerogatives of the Djuka witch doctors who, in their healing, use roots, herbs, nuts, etc., gathered in the jungle

efficient Dutch authorities, who give these black children free range of the rivers and jungle and treat so kindly their "Gran Gran Man," or river king, when he comes down annually for counsel with the Governor at Paramaribo, and lastly of the Djuka's great courage and his splendid work as a river man, in his frail dugout canoe, completely mastering the mighty streams and fierce treacherous rapids. The Djukas are a proud people, deserving admiration and respect, and a people well adapted to their environment.

I wish to acknowledge my deep appreciation for the aid furnished me by E. W. Rogalli, Chief Forester, Mr. J. W. M. Strang, and Mr. Alexander Wolff, of Paramaribo, without whose advice and assistance my little journey would have been impossible.

A MODERN "MEDICINE MAN" IN CHINA

A Herpetologist from the American Museum Collects Lizards, Frogs, and Snakes in Fukien Province and Finds Them Admirable Creatures

By CLIFFORD H. POPE
Assistant Curator of Herpetology, American Museum

THAT the farmers of Fukien Province had no conception of my real reasons for collecting frogs and snakes and lizards was obvious enough. But because the Chinese use these creatures for medicine and because, for a thousand years, Chinese "medicine men" have gone about collecting them, the tea pickers of Fukien merely imagined that I was another "medicine man" gathering cures for my people beyond the sea. I did not always try to correct the idea, for they were willing to bring me specimens for such purposes and I was not sure whether they might object if they learned that my reasons were far different. So it was as a "medicine man" that I studied and observed and collected, and the tea pickers about my laboratory accepted me as such.

On one occasion a crowd of these people gathered about me in a circle around a pile of decaying bamboo waste high in the wild mountains that separate the provinces of Fukien and Kiangsi, while I, with the help of one or two of the onlookers, was photographing a small, brown pit viper that lay beside a batch of white eggs in a small cavity in the mass of waste. The snake tenaciously guarded its eggs against all odds, refusing to budge an inch until the eggs had actually been removed. Only then did it try to escape. Anyone would have been impressed by this display of reptilian courage. However, its only reward was an alcohol "grave" in a museum's study collection.

On another occasion a harmless water snake (*Natrix percarinata*) was brought in with a lot of eggs. The snake remained quiet as long as it was near the eggs, and when put in a tin can with them, it coiled itself about them and did not try to get away. Ordinarily, when captured, this species is terrified and makes violent efforts to escape.

Snakes do not deserve the reputation of being slimy and ugly and cowardly. On the contrary, they are not only clean and beautiful and graceful, but courageous as well. Some kinds, it is said, even protect their young by swallowing them in times of danger, but there is no positive proof that this is true.

Fukien Province has a widely varied snake fauna, no less than sixty species having been recorded from there. By far the greater number of these are harmless, though some of the deadliest and most dangerous of snakes, such as the cobras, are on the list. The giant among the Fukien snakes is a python which, it is said, attains a length of more than twenty feet, while the tiny wormsnake (*Typhlops braminus*) represents the other extreme. The wormsnake could easily be mistaken for an ordinary earthworm and is often found in flower pots. Neither one of these two extremes of size possesses a poison apparatus, so both are really harmless, though the python is not devoid of strength. It has the reputation, however, of possessing much greater crushing power than it actually has.

In killing its prey the python strangles rather than crushes. Once it has coiled itself about an animal, the snake tightens its grip firmly about the struggling body at each successive expellation of breath. As the efforts to breathe become more and more spasmodic, the victim quickly loses strength and suc-

FOOCHOW, CHINA

This city was, in the days of the clipper ships, one of the leading ports in China. Since the decline of the tea trade, however, it is no longer important in foreign trade. The famous "Bridge of Ten Thousand Ages" can be seen in the distance

cumbs, though the python has really done little more than hold the ground that the animal has unconsciously given it. Thus, Nature has given the python a labor-saving method of overpowering its prey. It practices the principle so well understood by the jiujitsu wrestler who merely helps an opponent to overcome himself. It is doubtful if the python has sufficient strength to crush the bones of a big mammal. It is also doubtful if one of these snakes would use its power of constriction in a purely defensive battle. More likely it would simply strike and bite in ordinary snake fashion.

Extremes in size among the poisonous snakes of Fukien, though not so great as among the harmless varieties, are nevertheless very marked. The pit viper that guards its eggs so bravely is less than two feet long, but the king cobra (*Naja bungarus*) reaches an enormous size and is, in fact, the largest poisonous snake found anywhere. A specimen eighteen feet long has been recorded. This giant snake ranges through China's southern provinces, where it enjoys the well-deserved reputation of being extremely dangerous. Mankind is not alone in its fear of this terrible creature, for it preys upon other snakes which are said to form a large part of its diet. Cannibalism is not practiced by man alone!

Elaphe carinata, a big, harmless, black and yellow snake common over a large part of China, proved itself a first-class collector, securing for us a new variety. One day two of us were out hunting in a bamboo forest, when we heard a noise on the trail ahead. We hurried and arrived just in time to see a large *carinata* tumble across the narrow trail and slide down the steep mountainside below—a most peculiar performance

for a snake. It seemed to have lost its footing. Following, we soon found it hidden among the rocks. It looked rather too plump. We felt of its body and were convinced that it had just finished a meal, so we squeezed its stomach. Out slid the interesting new variety in perfect condition. After being cleaned in the stream it was as active as if nothing had happened to it. Its devourer was none the worse for the experience, either. On another occasion my skinner removed from the stomach of one of these cannibalistic snakes two victims, one a half-grown viper and the other a snake actually longer than the devourer. Both, though dead, were yet undigested. This shows what an appetite *carinata* has. However, cannibalism among snakes is not very common for, from about a hundred species with which we worked in China, we secured evidence proving that only two species have developed the habit to a marked degree. Most snakes prey upon frogs, lizards, or small mammals, such as rats, mice, and moles. These are not chewed, but are swallowed whole. The lower jaws of snakes are connected by ligaments which, in stretching with the skin, allow proportionately enormous objects to pass.

A small *Pseudoxenodon bambusicola* was caught by one of my collectors near Yenping. In spite of such a formidable name the snake is harmless. It tries, however, to create the impression that it is quite dangerous. The little *bambusicola* behaved in a most astonishing manner when teased. It first flattened its head, neck, and body, to such a degree that the scales were widely separated on the stretched skin and its color pattern stood out vividly. This maneuver failing, it inflated its body and even drew its lips up so that it appeared to be "snarling." When further annoyed, it opened its mouth and struck, but not in a convincing

A PEACEFUL SCENE ON THE RIVER MIN

Off to the right great numbers of boats may be seen packed closely together. Hundreds of people make their homes on these boats and seldom venture ashore

THE VILLAGE OF "SEVEN MILE BRIDGE"

Mr. Pope's headquarters were three miles down the valley from this group of houses. It was among these Fukien mountains and valleys that he collected his specimens

PREPARING TO CROSS A RIVER ON THE FUKIEN PLATEAU

The raft seen in the foreground is made of six giant bamboos, and, because of its shallow draft, is especially useful on swift streams

A CAMPHOR-WOOD BOAT SPECIALLY CONSTRUCTED TO SHOOT RAPIDS
In this boat the party descended from the plateau of northwest Fukien to Kien-ning, which lies about 150 miles upstream from Foochow

MEALTIME ON A CARGO BOAT
Each man fills his bowl from a wooden rice bucket around which all squat as they eat their meal and discuss local news

ON A MOUNTAIN TRAIL

These coolies chose to carry about 125 pounds each, despite the roughness of the ancient paths. The trails are often very abrupt, and a misstep could easily precipitate the unwary person hundreds of feet into the valley below

way. In fact, it did not really bite. The whole performance was an imitation of the defensive actions of some of the deadly snakes. Finally, it tried turning on its back as if dead. This it did repeatedly. Was it "playing possum" with us? There is one American snake, the so-called "spreading adder" that uses this same trick but goes the Chinese snake one better. If, after it has feigned death, one turns it on its belly, it will immediately turn on its back again! Apparently its idea is that a dead snake lies only on its back.

One might almost say that such snakes have personalities. Of all my ophidian acquaintances, the one whose individuality stands out most vividly in my mind is the green bamboo viper (*Trimeresurus*) of southeastern Asia. In the mountain form the entire body is leaf green except for an inconspicuous lateral line. Even though this snake is a true pit viper and possesses perfect hollow fangs, the bite is seldom fatal to man, although the venom would certainly make one very ill.

It was in the wild mountains of Fukien that this snake nearly brought about a division in camp. A local mountaineer strolled in one day carelessly swinging a fine specimen in one hand. Kang, my taxidermist, refused to buy it, contending that its fangs must have been removed in order to render it so harmless. I arrived just in time to avert a row by examining the snake and finding its fangs in perfect condition. The collector's feelings were so hurt by Kang's behavior that he refused to sell the snake at any price, and departed. He returned later, however, fully recovered, and explained to us that these vipers, if handled gently, are so docile that there is no great risk in carrying them around in the bare hands. This time he brought with him no fewer than ten, and proceeded to drape them over pegs and clothes lines, declaring that they would "remain hanging over night." They actually were reluctant to drop to the ground, so his statement was true to a

degree. In spite of all this, I have seen individual vipers that would strike viciously at any object brought near them, although it may be that they do not bite anything actually in contact with their bodies—a hand for instance.

One night I was attracted by a strange frog call coming from the side of the stream up which I was working. There was nothing to do but sit and wait, for every time I went toward the sound, the call stopped. After some time of fruitless waiting I looked down and saw a tiny green viper approaching. It drew near but finally stopped and lay on a twig quite motionless. Wishing to verify its appetite for frogs, I took one from my bag, tied a thread to its legs, and dangled it before the snake. The viper was not slow to act, it seized the frog in a wink, and devoured it forthwith. To my chagrin I found, a few minutes later, that the devoured frog was no less than one of two specimens of a new species I was carefully saving. It was too late to regain it, however, for the satisfied snake had already disappeared, little caring that it had eaten a "new species" out of the hands of one who had come half way around the world to secure it. In the meantime the author of the new call had become so alarmed by the strange proceedings that, though I waited from one o'clock to daylight, it scarcely stirred again, and to this day remains a mystery.

The green viper was only a visitor to the stream, but another snake, a drab-colored fellow with a small head and body, was a real cascade inhabitant. It is called *Tapinophis latouchi*, after Mr. J. D. La Touche, its discoverer and the second collector to visit this region. *Latouchi* has adapted itself to life among rocks and gravel through and over which cold, clear water pours. There it burrows in search of earthworms. Prolonged exposure,

GATHERING POISONED FISH

Since time immemorial these mountain people have caught fish by poisoning the streams. A vegetable poison is used, and the effect is very rapid, but fortunately it is not very far-reaching

A VIPER ON ITS NEST

This snake tenaciously guarded its eggs against all odds, refusing to budge an inch until the eggs had actually been removed

A LEGLESS LIZARD

This "glass snake" is not a snake at all, but is, instead, a lizard without legs. It, too, lays eggs, but unlike the viper, takes flight when it is disturbed on its nest

A SNAKE'S EGGS

Each of these eggs is about the size of a small plum. This nest was found by twelve-year-old Ming Fa, who also caught three large snakes near by and brought them to Mr. Pope alive and uninjured

THE HOLLOW FANGS OF A PIT VIPER

Despite its dangerous armament, this reptile is of a docile nature, and is not given to unprovoked attack

PREPARING A SPECIMEN

Yu Fa, collector, and "Young Tang," reptile preparator, are shown about to skin a good specimen. The largest snakes were skinned rather than preserved entire

however, to ordinary air temperatures invariably brings on its death. It is a night prowler and must be dug out during the day. This snake is timid and does not defend itself, save by the production of a mildly offensive odor.

I have often been asked how one avoids being bitten when hunting snakes in a country inhabited by both cobras and pit vipers. The answer is simple. Although we secured in Fukien during our sojourn of a year and a half approximately 1500 snakes representing about 55 species, and though I frequented the most snaky places I could find during eight or ten hours of every twenty-four, it is doubtful if I personally encountered a dozen poisonous snakes. Practically all of those I saw were sluggish pit vipers and only once was I in a precarious position in relation to one.

On that occasion I happened to be looking for frogs in a field, when my trousers almost brushed the upturned snout of a huge pit viper (*Agkistrodon acutus*). The snake, though coiled, did not strike. This is a typical instance of reptilian manners and decency. My guide, a twelve-year old Chinese boy, saw the snake and called me back, but he was very indignant with me when I helped catch it, for he feared that my interference would jeopardize his reward.

All of the Chinese farmers assumed that we carried vast stores of medicine that would instantly cure the bite of any creature. This was most unfortunate, for these trusting souls handled deadly reptiles with the utmost carelessness, and I had no good medicine whatsoever with which to cure snake bite. A man once brought me a cobra with which he had walked five miles over the mountains through a hard rain. He also brought a note from a mutual friend, telling me that the snake had bitten the fellow and imploring me to cure him. He had, however, already cut

away the flesh from around the wound and cured himself. The actions of these folk are in strong contrast to those of a Virginian of my acquaintance, who, though living in a region practically free from venomous reptiles of any description, had for two score years avoided grassy fields and meadows for fear of being bitten by a snake!

If one will only stop to consider snakes as they deserve to be considered, it is easy to see that they are fascinating creatures full of popular as well as scientific interest. When we study birds or mammals we do not hold against them the fact that here and there we find an objectionable or dangerous species. As a matter of fact, with mammals, the more dangerous one of them is the more certain he is to attract attention. Why is this not true of snakes? By far the largest percentage of them are not only harmless but are, in addition, friends of man. Yet we go about with the fear of snakes in our hearts and with superstitious notions of snakes in our minds, with the result that we rarely get acquainted with them and, of course, learn very little indeed about them.

The study of the behavior of snakes is only in its infancy, and much remains to be done in that field. Thousands of people, these days, entertain and instruct themselves by taking bird observation hikes and outings. Why should they not combine the study of reptilian and amphibian life with their other observations, or why should they not carry on such observations alone? Unfounded fear and silly superstitions undoubtedly interfere, but once they are free of such handicaps—as many observers agree—the way is open to a new and a fascinating field of study and entertainment.

YU FA'S SON POSING AT THE DOOR OF A TIGER TRAP

Wisely, the Chinese tea-grower builds his tiger trap as an annex to his pig pen. Thus the pig serves as bait, but lives in safety the while

INSECTS THAT ERECT TENTS

The Problem Presented by the Tent Caterpillar and Nature's Method of Controlling Its Numbers

By FRANK E. LUTZ
Curator of Insect Life, American Museum

THERE is a moth which, while still a caterpillar, joins with its young brothers and sisters in constructing a silken tent that forms a community dwelling. You have all seen the tents of this species (*Malacosoma americana*), and during the past several years many of you have either gathered or encouraged others to gather and destroy the over-wintering egg masses. I wish that I were more certain whether such destruction is wise or at least worth while. I shall presently say why the doubt has arisen, but apparently there was none in my mind about ten years ago when I was writing the *Field Book of Insects*. A paragraph there starts out appreciatively enough:

> If the tent caterpillar were not so common and such a pest, we who are interested in Nature would be willing to go miles to see a colony. We might even bring eggs home so that we could have it in our garden.

But it ends in dull pessimism:

> Considering that Nature helps us by giving this species many enemies, that the larvæ gather in all too conspicuous webs where we may conveniently burn them, and that even the eggs may be easily seen and removed during the winter, it is strange that people allow *M. americana* to exist. The reason probably is that its extermination requires community action. Last winter I picked all the egg masses off my trees; in the spring the editor of our country paper published a long article telling how to combat the tent caterpillar; he lives across the street from me but he did nothing to the big colonies on an old cherry tree in his yard because he was going to cut the tree down in the autumn; this winter I must go all over my trees again.

Several years later I wanted to get a few egg masses for a certain purpose. There were none in our yard or even in the editor's. I scoured the neighborhood and went to the edge of town, where there are plenty of wild cherry trees, without finding enough to have made the trouble worth while. What had happened? I am not sure; but this species is a native of America and, during its centuries of residence here, it has become so fitted into its environment that a "balance of nature" exists. The beams of this balance are not stationary; they swing through such a wide arc that at one time the species seems about to eat up all vegetation (despite the fact that it really eats but few kinds of leaves), and at another time an experienced entomologist must hunt long to find only a few of its conspicuous (when present) egg masses; but swing it does. We can be certain that "it is darkest before dawn." Just as truly, of course, it is lightest before night-fall, but that isn't usually mentioned.

When the tent caterpillars, or "webworms," become very abundant, Nature, without help from her human species, does something that reduces their numbers. Then she lets up a bit, and the caterpillars, or "worms," become abundant again. The crests of the waves are ten or a dozen years apart. If you prefer the other metaphor, it takes about that long for the balance of nature to make a complete swing in this instance. Just at present the caterpillars are on the down grade, and last year, at our Station for the Study of Insects near Tuxedo, N. Y., Mr. F. M. Brown found that one probable cause of the decrease is the presence of what was then an undescribed bacterium attacking the eggs. Such being the case, when you

collected and burned the egg masses, you also collected and burned one of Nature's agents in maintaining the balance between species. Was that wise? I do not know. Perhaps you were helping Nature, but I almost doubt if it was worth while, since Nature was doing a fairly good job by herself.

One thing that we may eventually be able to do is to learn how to use in our own interests the agents which Nature uses. If, when her parasites of plant-eating insects are so abundant that they are dying out for want of food, we could keep them going and let them loose as we need them, much would be gained. It would be like collecting water in a reservoir to be used for irrigation during the dry season. It is one of the many tricks that we still have to learn in our attempted control of those particular insects that injure us.

If we wish our collecting of tent caterpillar egg masses to do the most good, we should collect them during the years that the wave of abundance is low or rising, not in the years that it is at its crest or falling. However, like the celebrated house owner, we do not pay much attention to the roof when no rain is falling.

There is another thing involved in these decennial excitements about the tent caterpillars. The adult moths eat nothing at all. They emerge in midsummer, mate, and each female capable of doing so lays a broad band of eggs around some twig, covering the eggs with a fluid that hardens into a weather-proof varnish. Then the adults die and their offspring do not hatch until the following spring.

The female lays her eggs around some twig, but she does not lay them around just any sort of twig. Almost always, although it may not seem so to the owner of apple trees, she selects a cherry twig and apparently strongly prefers a native, or "wild," species of cherry. Like dutiful children, her offspring eat what is set before them, and, since that is usually wild cherry, the damage they do is largely confined to wild cherries, among the least valuable of trees to man, however much certain birds may enjoy the fruit.

A natural and often-made suggestion is that, if we get rid of all of the wild cherries, we shall deprive the tent caterpillars of their favorite food, and we shall not see so many of their tents. (It seems that the unsightly appearance of the tents disturbs many people more than seeing the leaves being eaten.) Such destruction of wild cherry seems almost like burning down a barn to get rid of the rats, but leaving its feasibility and desirability out of account, I fear that all that it would accomplish would be to force the mother moths to change their egg-laying habits and concentrate on, say, apple trees—the rats would move from the burning barn to the house.

Photograph by M. C. Dickerson

A FAMILY TENT

"If the tent caterpillar were not so common and such a pest, we who are interested in Nature would be willing to go miles to see a colony"

How the mother moth chooses the twigs upon which to lay her eggs is really a mystery not easily to be dismissed by saying that she uses her sense of smell.

Photograph by M. C. Dickerson

EATING, GROWING, SPINNING

These are the tasks which Nature gives a caterpillar. Are these tasks done by instinct or by intelligence or do we need another word?

If she does choose by odor, is it the smell of the leaves or of the twigs? Last year I made a large cage in which I put dozens of moths. At one end of the cage I put wild cherry twigs without leaves and surrounded them with leaf-bearing twigs from various other trees. The wild cherry twigs were of the diameter usually selected by the moths but the other twigs were either too large or too small. At the other end of the cage things were reversed. The vase there contained leaf-bearing wild cherry twigs too thin to suit the moths, and in among the leaves were twigs of the right size but from other kinds of trees. If the mother makes her choice on the basis of bark, the eggs would be placed on the leafless wild cherry twigs in the first end of the cage; if on the basis of leaves, they would be on some alien twig among the wild cherry leaves at the other end of the cage.

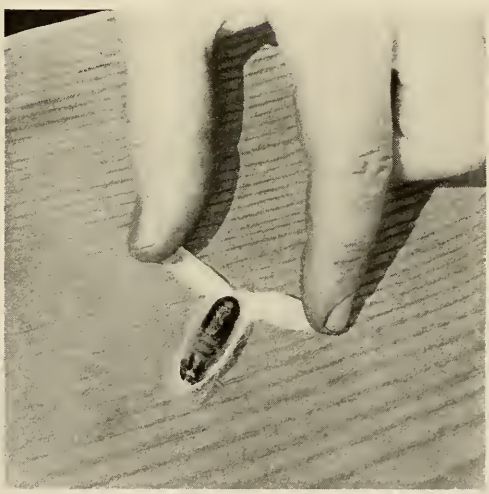
I was quite excited. It was a beautiful experiment; but it didn't work, because only one somewhat deformed egg mass was laid, and one egg mass, deformed or otherwise, did not seem sufficient to establish such a point. The trouble seemed to be another one of Mr. Brown's undescribed bacteria, this one attacking the egg-producing apparatus of the female moths. They were too sick to lay eggs. If so, that is another way in which Mother Nature swings her balance back. The idea is somewhat confirmed by the fact that there were very few egg masses in this general region last winter, even where school-children did not pick them at so much a hundred. The result so far as I am concerned is that I must either wait six or eight years before I can repeat the experiment, or I must go to some part of the country where the tent capterpillars are riding the crest of their wave instead of being on the down grade.

At any rate, we know that the mother of tent caterpillars, like other mother moths, can do more than we can. In the dark she can select out of a whole forest of mixed trees a particular kind of tree. It is the kind upon which she fed before she changed from a "worm" to a pupa and then from a pupa to a moth. In the case of *M. americana* only a few weeks elapse

between the last larval meal and the emergence of the adult to lay eggs, but many moths spend months as dormant pupæ enduring the cold of winter. When they finally emerge, do they still remember the sort of food they had eaten the previous year and before the two great bodily changes that took place since last they ate? If so, what do they remember? Surely it is not taste that guides them, for they not only do not fly around tasting leaves until they find the right kind, but adult moths could not eat leaves if they tried. Even when they have functional mouths, they can do nothing but suck fluids. If not taste, what? We run through the few human senses and conclude on the basis of them that she must hunt out the tree by smelling. Possibly we are right, but we must remember that we have still much to learn about insects, and that, if our noses were just a wee bit poorer than they really are, we would not know what smelling is, and so would not think of it.

This discussion reminds me of "instinct," a most convenient word to use on certain occasions. The tent caterpillars' mother selected wild cherry by instinct. It was instinct that led her to fasten her eggs in a bandlike mass around the twig and to cover them with a weather-proof varnish. The eggs develop before cold weather so that the young caterpillars are ready to hatch, but it is instinct that keeps them from bursting the protecting eggshell until early in the next year, when there are fresh young leaves to be eaten. It is instinct that holds the new-born family together and teaches them to build a communal tent out of their saliva. It is instinct that changes their gregarious habit when the larval stage is nearly completed and drives each caterpillar its own way. It is instinct that helps the wanderers to find safe nooks in which to spin cocoons.

When we cannot explain the action of an insect in any other way, we call that action instinctive, although other terms sounding more learned but explaining no more have been invented for certain actions. For example, when the full-grown caterpillar stops feeding and climbs down the tree trunk, it does so "because it has become positively geotropic." This means exactly what it says— and no more. The caterpillar "turns toward the earth." The caterpillar is also "thigmotropic"; in other words, it turns toward contact with solid objects, as much contact as it can get, and, when satisfied, it stays there to spin a cocoon. This, combined with "negative phototropism" (turning away from light) at that particular time explains why cocoons are made in hidden nooks. But does it? Have we really explained anything or have we merely described the caterpillar's action in fine-sounding, learned-looking terms?



Photograph by Frank E. Lutz

TENT CATERPILLAR'S COCOON

Opened to show the mummy-like pupa—a live "mummy," for in it a caterpillar is changing to a winged adult

As to "instinct," I pleasantly spent a part of one Sunday afternoon reading a noted psychologist's essay on mental

evolution in the light of modern knowledge. He says that at a given stage

> .... two possible courses lay open, by either of which a nicer adaptation to a greater variety of objects and conditions of environment might be achieved. One of these lines was the greater specialization and differentiation of the instincts, the innate mental dispositions, the racial mental structures, which express themselves in instinctive behavior. The other line was the increase of intelligence, or power of adaptation of instinctive reactions to the varying circumstances under which they are evoked. In the main the evolution of the higher insects followed the former line; that of the vertebrates followed the second course. This divergence gives some plausibility to Professor Bergson's sharp separation of instinct from intelligence. But M. Bergson has, as it seems to me, very seriously overstated the distinctness of the two functions and the two lines of evolution. Instinct and intelligence are not two distinct kinds of mental function; they are rather two abstractions that we make by considering mental process in two aspects in turn. All mental process is both instinctive and intelligent; it is instinctive in so far as it is determined by innate mental structure; it is intelligent in so far as it involves adaptation to the particular circumstances of each occasion, circumstances not provided for in racial mental structure. The vertebrates, in developing along the line of intelligence, did not abandon their instincts. Nor did the insects, in acquiring more highly specialized instincts, cease to be capable of some degree of intelligent adaptation of instinctive behavior.

Fine. There is a young wild cherry tree at the back of our yard. I think that I shall let it support a family of tent caterpillars each year. Possibly some day a psychologist will discover that they are almost human, either because their actions are more intelligent, or human actions are more instinctive than we now believe, or that neither instinct nor intelligence is anything other than tropism. At any rate, these insects are interesting pests and they are native to this country.

MATING AND EGG LAYING

These are the main duties of adult moths. By what devices does the male find its mate, and the female select the proper twig on which to place her eggs?

NEW WORLDS IN THE MAKING

Facts, Theories, and Hypotheses that Explain, or Try to Explain, How and Why the Earth and Other Astronomical Bodies Were Formed

By CLYDE FISHER
Curator of Astronomy, American Museum

EVERYONE discovers the universe for himself, and after some observation of the apparent behavior of the heavenly bodies, one begins to wonder about their origin. There is abundant evidence that the earth has not always been just as it is now. We cannot believe that the beds of coal, the deposits of sandstone and limestone and marble, the fossils in the rocks, and the Grand Cañon of the Colorado were created as they are. Even a superficial study of geology convinces one that "there is nothing unchangeable except eternal changeableness,"—that all of these and other features have undergone a long series of changes, that they have a life-story, if we can but read the record. The more we examine the worlds outside of ours, the more we are persuaded that changes have been going on throughout the universe.

Very early in our lives we notice that the sun rises in the east, passes across the sky, and sets in the west—surely one of our earliest astronomical observations—and to each one of us this seems as real as it did to our forebears of not many centuries ago, who believed that the sun went round the earth. Due to similar observations on the moon and stars, it was believed that the earth was the center of the universe.

It was not until the astronomers had made the important distinction between real and apparent motions, not until they understood that the sun was the center of our solar system, could any intelligent theory for the origin of these bodies be framed.

The first scientific theory of origin of our solar system, and it was a magnificent conception, goes back to the philosophers, Kant and Swedenborg. Since it was developed and put into scientific form by La Place, it was known as La Place's Nebular Hypothesis or Theory, depending upon the credence given. A hypothesis is more than a guess. It must have some evidence in its favor, and must not be contrary to proven facts. A theory must have more evidence in its favor, and a law is a theory proven beyond doubt. So, hypothesis, theory, and law are relative terms, there being no hard and fast lines in nature.

According to the Nebular Theory, the sun and all of the planets and their satellites and the asteroids were once a huge, rotating, gaseous nebula, which extended out beyond the present orbit of Neptune. As this nebulous mass cooled, it contracted, and, since we recognize no resisting medium in space, the speed of rotation increased. As the whole mass contracted, the circumference grew correspondingly smaller, so that the part at the surface went round more times in a given period. This increase in the speed of rotation was accompanied by increase in centrifugal force, or the force by which a revolving body tends to fly *from* the center.

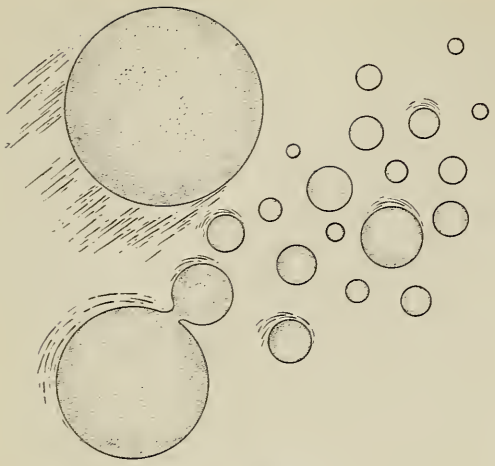
So it was with the mass of the outer part of our theoretical nebula, and when this force had increased until it balanced

THE "NORTH AMERICA" NEBULA

This nebula, which bears a striking resemblance to the map of North America, can probably not be seen even with a telescope, but it can be photographed by a long time exposure. Photographed with 10-inch Bruce lens, by Barnard

PORTION OF THE MILKY WAY

Near the star Theta in the constellation Serpent-bearer (Ophiuchus), is a remarkable vacancy in the Milky Way, shown here as a dark patch surrounded by myriads of stars. Photographed with the Bruce telescope, by Barnard



A NEAR COLLISION

Diagram to illustrate the "dynamic encounter" between our sun, which is a star, and another star, at the birth of the planets of our solar system

the pull *toward* the center (centripetal force or gravity), then the inner part of the great nebulous mass contracted away from the outer rim or shell of the nebula. This rim or outer shell was not thrown off like drops of water from a grindstone or mud from a carriage-wheel, but was *left* balanced between centrifugal force and gravity, and still rotating. This rim or shell, which may not have been complete, or even uniform in thickness, was supposed to collect together in a more or less globular mass, according to the theory of gravitation by which every particle of matter attracts every other particle. Thus the outermost planet was formed, and in the same way the rest of the planets were successively formed, the one nearest to the sun being the last to be formed. In the case of the asteroids, or tiny planets which occur between the orbits of Jupiter and Mars, it is supposed that this shell, instead of collecting together in one mass, gathered together in more than one thousand small masses.

The moons or satellites of the planets were supposed to have been formed in the same way, after each individual planet-mass had been left balanced between gravity and centrifugal force, and still revolving around the central portion of the original nebulous mass.

As the nebulous matter condensed and cooled, it changed from gaseous to liquid form and then to solid, in the case of the four terrestrial planets, as Humboldt called the four inner ones, Mercury, Venus, Earth, and Mars. The four outer or major planets, Jupiter, Saturn, Uranus, and Neptune, still seem to present only an outer surface of cloud.

When the nebular theory was first conceived, it was thought that there were two kinds of evidence in its favor, namely: First, features in our solar system whose existence the theory would account for; and second, systems outside of our own which are now in phases suggesting the early phases of our own system.

Evidence of the first kind was most impressive, for it was thought the theory would explain the following conditions:

(1) The orbits of all the planets and asteroids are practically in the same plane (except those of some of the asteroids), which determines that these bodies occupy a narrow belt in the heavens only a few degrees wide. No planet is ever found near the North Star or even near the Big Dipper, and none is ever found near the Southern Cross, but all are always found in the narrow belt called the Zodiac.

(2) The orbits of all of the planets and asteroids are nearly circular (except for those of some of the asteroids).

(3) All of the planets and asteroids revolve around the sun in the same direction.

(4) The sun rotates on its axis in the direction in which the planets revolve, and its equator is but little inclined to their orbits.

(5) The planets of the greater density are nearer the sun.

(6) The moons or satellites revolve about the planets in the direction in which the planets themselves rotate

(except the eighth and ninth satellites of Jupiter and the ninth satellite of Saturn).

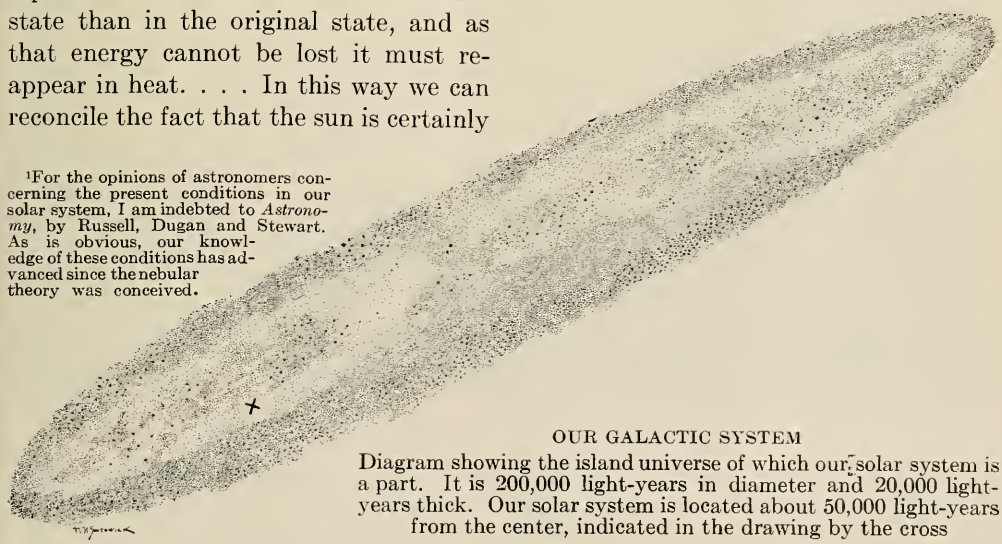
(7) The orbits of the satellites are nearly circular and nearly in the plane of the planet's equator (except for the eighth and ninth satellites of Jupiter and the outermost satellite of Saturn).[1]

It is not reasonable to suppose that such conditions as these are due to chance and therefore insignificant. If these relations were due to chance, we would have expected to find the planets and asteroids scattered over the sky and also that they revolved around the sun or around each other in many and diverse ways. On the other hand, the conditions, as they are, point to a common origin and to an orderly development.

A generation ago Simon Newcomb and other leading astronomers believed that the nebular theory was "almost a necessary consequence of the only theory by which we can account for the origin and conservation of the sun's heat." As the British astronomer, Sir Robert S. Ball, explains this phenomenon: "As the sun loses heat, it contracts, and every pair of particles in the sun are nearer to each other after the contraction than they were before. The energy due to their separation is thus less in the contracted state than in the original state, and as that energy cannot be lost it must reappear in heat. . . . In this way we can reconcile the fact that the sun is certainly losing heat with the fact that the change in temperature has not been large enough to be perceived within historic times."

The second kind of evidence, that is, phases in systems outside of our solar system, which suggest stages in the development of our own, consisted chiefly in nebulæ. No telescope has been made that is powerful enough to reveal planetary systems around any of the stars, besides our sun, even if they exist. The first nebulæ to be discovered, the Great Nebula in Andromeda and the nebula in the sword of Orion, can be seen with the naked eye, and many more were discovered with the telescope. Sir William Herschel observed faint diffused nebulæ, others in which a nucleus can just be discerned, and others in which the nucleus is a brilliant starlike point. And the spiral nebulæ certainly appeared to be solar systems in the process of development. Larger telescopes resolved some of the so-called nebulæ into stars. At first this was thought to be fatal to the nebular theory, because of the natural conclusion that still larger telescopes might resolve the rest of the nebulæ into stars. But the invention of the spectroscope proved that some nebulæ were irresolvable. Thus spectrum analy-

[1]For the opinions of astronomers concerning the present conditions in our solar system, I am indebted to *Astronomy*, by Russell, Dugan and Stewart. As is obvious, our knowledge of these conditions has advanced since the nebular theory was conceived.



OUR GALACTIC SYSTEM

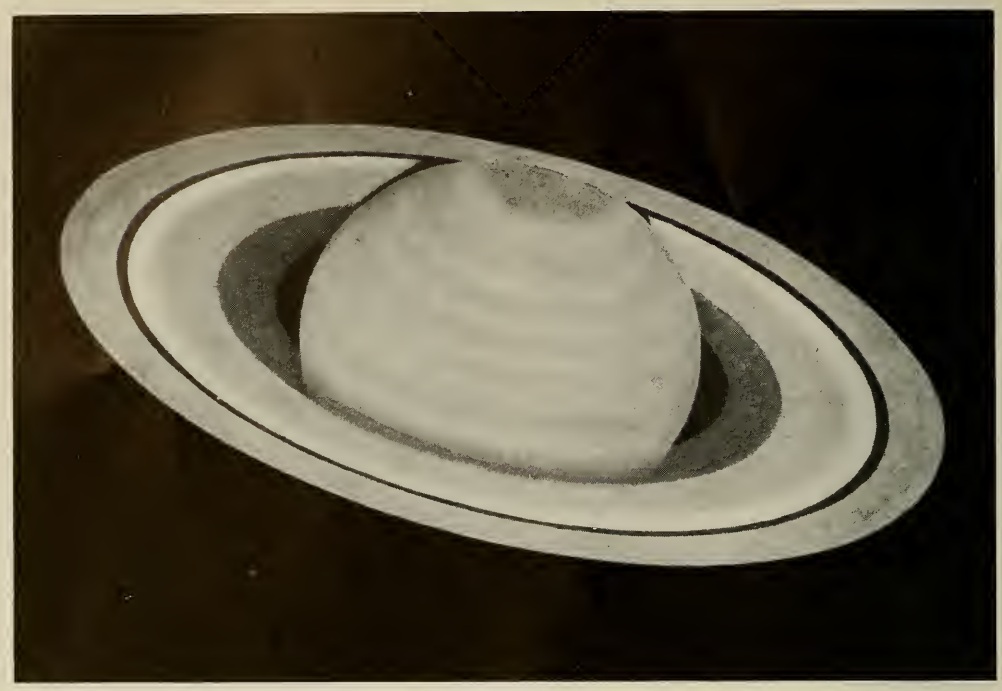
Diagram showing the island universe of which our solar system is a part. It is 200,000 light-years in diameter and 20,000 light-years thick. Our solar system is located about 50,000 light-years from the center, indicated in the drawing by the cross

AN ISLAND UNIVERSE—EDGE VIEW

Our own galactic system, if photographed edge-view from a distance of a million light-years, would probably look something like this spiral nebula (H. V. 24), in the constellation of Coma Berenices, which is between Arcturus and Leo. The dark band shown in this photograph is probably due to a ring of dark matter lying in the plane of the spiral and outside its visible extensions. Photographed March 6 and 7, 1910, exposure five hours, with the 60-inch reflector at Mount Wilson Observatory

GREAT NEBULA IN ANDROMEDA

This great spiral was the first nebula to be known, and it can be seen with the naked eye, although nearly a million light-years distant. The spectroscope proves that it is not a gaseous nebula, as formerly thought, but that it is an aggregation of millions of stars or suns. Our own galactic system is probably much like this island universe in form and in character. The spectroscope shows that the Great Nebula in Andromeda is approaching us at the rate of 200 miles a second. Photographed with 24-inch reflector, by Ritchey



SATURN AND HIS RINGS

The rings of Saturn are now known to be composed of myriads of tiny moons. Drawing by Barnard as seen through the 40-inch refractor at Yerkes Observatory, on July 7, 1898, when the rings were opened to their fullest extent

sis reëstablished the nebular theory on a firmer basis than ever.

As investigation has gone forward in recent years, the nebular theory has lost the weight of the evidence thought to be furnished by the spiral nebulæ, for these are now believed to be immense island universes outside of our own galactic system.

The abandonment of this splendid speculation, the nebular theory, by present-day astronomers, seems to be due to two difficulties. First, according to Russell, Dugan and Stewart, "it can be proved that an extended tenuous ring would not condense into a single body, but into many bodies, like the asteroids or the rings of Saturn. Second, almost all the angular momentum of the solar system—98 per cent of the total—is at present associated with the orbital motions of the major planets (Jupiter, Saturn, Uranus, and Neptune). The sun's rotation provides almost all of the rest, the four terrestrial planets (Mercury, Venus, Earth, and Mars) contributing less than one tenth of one per cent of the whole. The total angular momentum cannot be altered by any internal changes within the system, and no process has ever been imagined by which 98 per cent of it could have been segregated in less than $\frac{1}{700}$ of the total mass." *Angular momentum* may be defined as "the product of the mass of the moving particle into the area swept out in unit time by the line joining it to a given point."

The nebular theory attempted to explain the origin of the solar system under the action of forces entirely within the system, but this is now believed by many astronomers to be impossible. The present distribution of angular momentum is believed to be due to forces from the outside of the system.

About twenty years ago, Chamberlin and Moulton of the University of Chicago proposed an alternative theory, which would not be subject to the difficulties mentioned above. At first their theory was usually referred to as the planetesimal hypothesis, but now it certainly should be dignified by the term "theory." According to this conception, our sun in the remote past was a star without planets, and another sun or star (for all stars are suns, and our sun is a star) in its journeying through space came so close to our sun that it caused a tremendous disturbance, pulling out great masses of the sun and starting them on their revolution around the sun. By a kind of explosion, due to the disturbance of gravity, there were myriads of these masses projected into space, probably varying greatly in size,

VENUS IN CRESCENT PHASE

One can imagine the thrill that Galileo felt when, in 1610, he turned the first astronomical telescope toward Venus and found it to be a waxing and waning crescent. Since this planet shines only by reflected sunlight, it goes through phases as our moon does, and for the same reason. Photograph by Barnard through 40-inch refractor at Yerkes Observatory

THE PLANET MARS

Mars showing region of Syrtis Major. Note the cap, presumably of ice and snow, at the south pole of the planet. Photographed September 28, 1909, with the 40-inch refracting telescope at the Yerkes Observatory, by Barnard

and these were the so-called planetesimals. Not only was this new theory free from the fatal difficulties of the nebular theory, but it was found to explain the many features of the solar system, which pointed to a common origin by an orderly process, as well and in some cases better than the older theory.

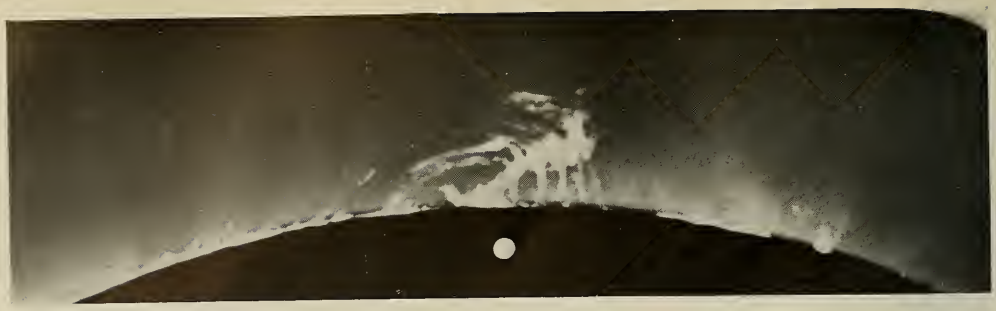
The myriads of planetesimals which were left revolving around the sun, by the action of gravity, were slowly gathered together into the planets, asteroids, and satellites. Perhaps the meteors are stray planetesimals, and perhaps the comets, which in some cases seem to be related to meteors, may also be accounted for by this theory. However, the comets have never been very

THE GREAT NEBULA IN ORION

Under favorable conditions, this amorphous, gaseous nebula, which surrounds the middle star of the sword of the Mighty Hunter (Orion), can be seen with the naked eye. It is within our own galactic system. The four-point, or cross effect, seen in a few of the larger stars in the photograph, is due to the supports of the mirror of the reflecting telescope by which the photograph was made. Photographed with 24-inch reflector, by Ritchey

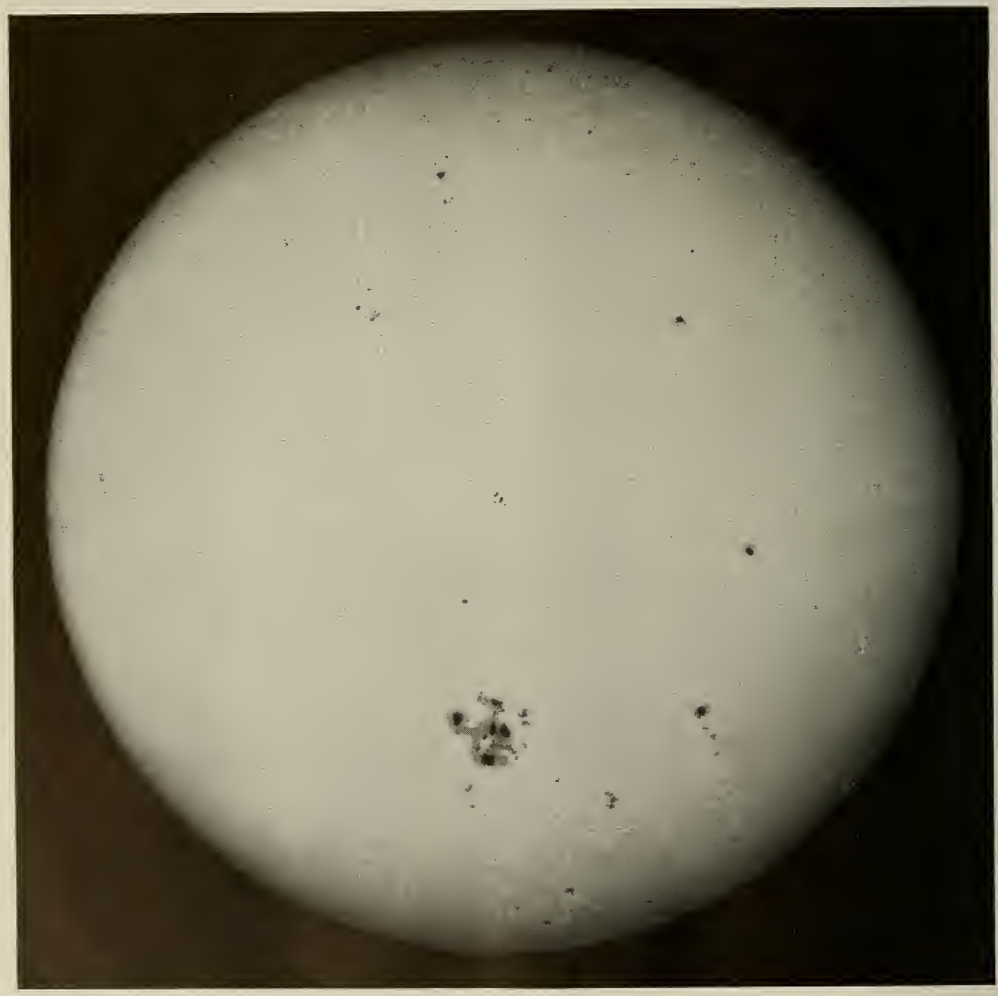
MOREHOUSE'S COMET

Morehouse's Comet swung around the sun in 1908 and was a rather conspicuous object in the sky during the autumn of that year. The telescope which held the photographic plate moved with the comet during the time exposure. Hence, the images of the stars are streaks rather than points. The tail, which always points away from the sun, seems to be made up of sheetlike streamers. Photographed with the Bruce telescope at Yerkes Observatory, by Barnard



"HELIOSAURUS" SOLAR PROMINENCE

At the total eclipse of the sun on June 8, 1918, there was a fine display of prominences thousands of miles high. The shape of this one suggested a prehistoric saurian,—hence the name. These prominences consist of hydrogen and helium. The small white spot just below the major prominence shows the relative size of the earth to this enormous eruption of flame. Photograph from the Yerkes Observatory



THE SUN AT THE PERIOD OF MAXIMUM SUN SPOTS

Sun spots are correlated with vortices in the vapor of the sun's surface, and vary in number according to a remarkable periodicity, eleven and a fraction years elapsing between one maximum and the next one. Since sun spots usually last a few weeks, one can observe the rotation of the sun on its axis by observing their position from day to day. Photographed with 12-inch refractor by Miss Calvert at Yerkes Observatory

definitely included in either the nebular theory or the planetesimal theory.

The craters on the moon, it was formerly believed, and many astronomers still believe, were of volcanic origin, but there is much in favor of the theory that they were caused by the impact of planetesimals or meteorites.

There have been modifications of the nebular theory not mentioned in this article, and there have been modifications or substitutions suggested for the planetesimal theory. Among the latter should be mentioned the tidal theory of Jeans and Jeffries, who agree with Chamberlin and Moulton in the encounter between our sun and some other star, and in most of the essential results of that encounter. According to the tidal theory, however, the planets must have possessed nearly their present masses from the time of "dynamic encounter," as Russell calls it.

EARTH-LIT NEW MOON

"The old moon in the new moon's arms," a slender crescent embracing the earth-lit night portion of the moon. We see the "old moon," or night portion of the moon, by means of "earth-shine," or light that has been twice reflected. The light from the sun strikes the earth, is reflected to the moon, and then is reflected back to the earth. Photographed February 14, 1907, with the 10-inch Bruce telescope at the Yerkes Observatory, by Barnard

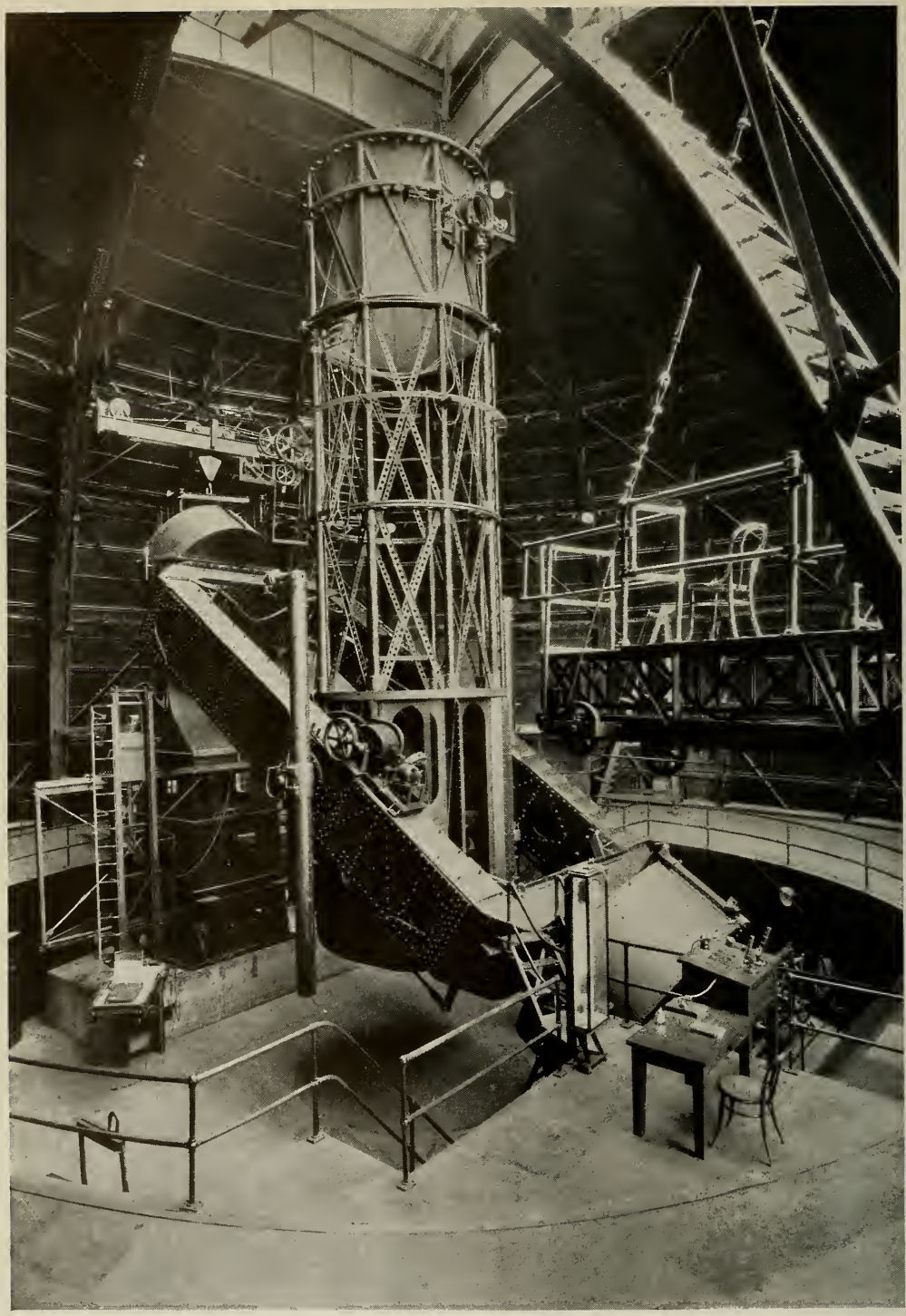
A brief, popular discussion of the planetesimal theory was given by Prof. Charles P. Berkey in his article on "Early History of the Earth," in the Astronomy Number of NATURAL HISTORY (July-August, 1926).

The age of our solar system, that is, the time that has passed since the great catastrophe which started its development, is estimated with a great probability to be from five to ten billions of years.

The spiral nebulæ, which it is

THE MOON IN GIBBOUS PHASE

The moon always turns the same side to the earth, and more than half of this side can be seen 9¾ days after new moon, as shown in this photograph. The craters show up well, as they do at first quarter and the two nights following. At this time the sun and earth are nearly at right angles in relation to the moon, and the shadows bring out the relief. Near the top (south pole) the great crater Tycho, more than eighty miles in diameter, is to be seen. Photographed with the 40-inch refractor at Yerkes Observatory



THE HOOKER TELESCOPE

This reflecting telescope at the Mount Wilson Observatory, Pasadena, California, is the largest telescope in the world, and has a huge glass mirror one hundred inches in diameter. With this instrument Hubble has been able to penetrate space to a distance of 140,000,000 light-years

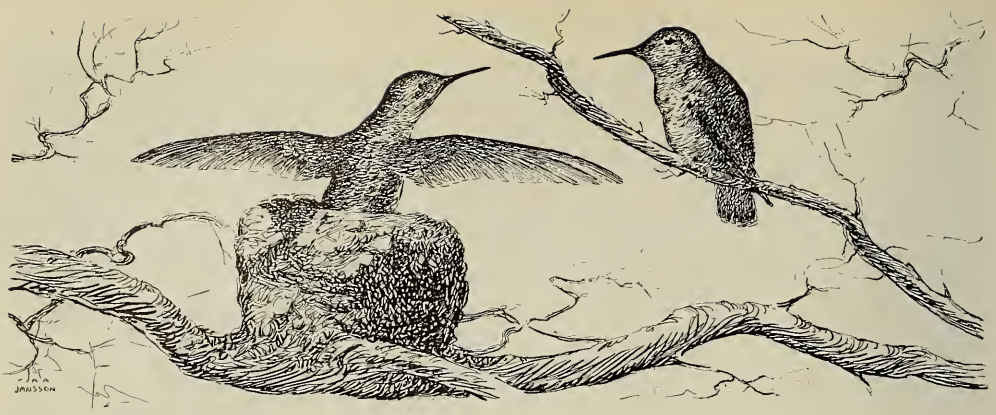
METEOR TRAIL IN THE SAME FIELD WITH THE GREAT ORION NEBULA
The bright streak on the left side of the photograph was caused by a meteor, or so-called shooting star, which happened to rush across the field while the exposure was being made. Photographed with the Bruce telescope, by Barnard

now believed are island universes, are inconceivably distant; the nearest one—the Great Nebula in Andromeda—is about one million light-years from us, a light-year being the distance that light travels in one year. When we recall that light travels 186,000 miles a second, or about 11,000,000 miles a minute, we are aided a little in our attempt to comprehend this tremendous distance. Yet many of these island universes are enormously more distant than this comparatively near neighbor.

These island universes, which were so fascinatingly treated by Dr. W. J. Luyten in the Astronomy Number of Natural History, are of especial interest to us, because it is believed that our sun is a part of such a universe, shaped much like the Great Nebula in Andromeda. According to Shapley, the center of our galactic universe is about 52,000 light-years from here and in the southern skies bordering on the constellations Sagittarius, Scorpio, and Ophiuchus. Our solar system is well within this watch-shaped galaxy and, when we look toward the rim, we see many stars, and call them the Milky Way. When we look toward the sides of our watch-shaped galaxy, that is, at right angles to the long diameter, we see only a fraction of as many stars, and for obvious reasons.

When we comprehend the relation of the earth to the solar system, and wonder about its origin, and when we get a glimpse of the relation of the sun to our galactic universe, and realize that there are thousands of island universes beyond the limits of ours, we naturally wonder whether they are in any way related to each other. The natural tendency of all knowledge to "unity and simplicity" makes us feel that they are.

> That very law which moulds a tear,
> And bids it trickle from its source,
> That law preserves the earth a sphere,
> And guides the planets in their course.
> —Samuel Rogers.



THE HOMES OF A HUMMER

A Study in Tropical Bird Life

By FRANK M. CHAPMAN
Curator-in-Chief, Division of Zoölogy and Zoögeography, American Museum

ON January 16, 1926, I found a violet-throated humming bird (*Anthracothorax violaccicollis*) building her nest. This statement obviously requires amplification. Bird students in eastern North America, at least, are familiar only with a ruby-throated, not violet-throated hummingbird, and they are accustomed to look for humming-birds' nests in June, not in January. However, if we should follow the five-hundred-odd species of hummingbirds throughout the vast territory their family occupies from Alaska to Patagonia, and from sea-level to the summit of the loftiest Andean peaks, we should probably find one or more of them nesting every day in the year.

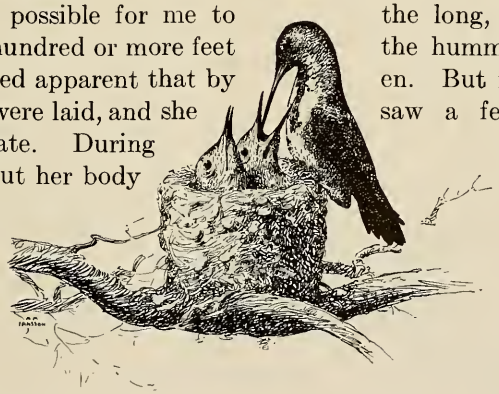
In any event, subsequent observation showed that on Barro Colorado Island in the Canal Zone, it is the habit of the violet-throated hummer to lay the foundations of her nest and her family in the first month of the year. Not only did this bird select a winter month, but she decided to place her nest in a tree already occupied by a score or more of birds many times her size. Nor did her peculiarities end here, for she chose as a site the terminal portion of a long branch projecting to windward and with not a leaf nearer than twenty-five feet. It was, in fact, the most exposed situation in the tree.

It is a very large tree, not less than one hundred and fifty feet in height and widely branched. There is, therefore, abundant room for many birds to build in it without interfering with one another. On the westerly side, where they were more protected from the strong trade winds of the dry season, a colony of oropendolas (*Zarhynchus wagleri*) were weaving their long, pendent bags on the outer branches. Nearer the heart of the tree a pair of blue tanagers (*Thraupis cana*) and of Colombian fly-catchers (*Myiozetetes texensis*) had made their homes. All were on excellent terms with one another and were doubtless quite willing to receive the humming-bird into the circle of their community life.

But the humming-bird had ideas of her own. The aggressive, pioneer spirit which has spread her kind from Magellan Strait to Bering Sea has not developed a feeling of sociability in her tiny body. She not only asked for the control of her corner of the sand-box tree but she de-

manded dominion over the entire tree, and what is more, she got it! Woe to the oropendola that ventured near her home. The fact that he was as large as a crow did not protect him. Like a winged terror she darted fearlessly at him, and evidently without thought of resistance, after dodging futilely once or twice, he would take to his wings. It was useless for him to retreat to his side of the tree. He was as helpless as a dirigible before a pursuit plane, and only the forest offered safety. Once on the warpath, the hummer attacked any bird that she chanced to meet, and not infrequently she cleared the tree before her raid was ended. Then, like a bit of down, she returned to her nest.

Fortunately for the other occupants of the tree, as the season advanced, the hummer's domestic affairs claimed an increasing share of her attention, and they were correspondingly free from attack. It was not possible for me to look into the nest a hundred or more feet from me, but it seemed apparent that by January 26 her eggs were laid, and she had begun to incubate. During this period nothing but her body stood between the eggs and destruction, one might say, from fire and water. Unshaded by leaf or branch, they might have been roasted if left exposed to the sun, and the nest-cup would have been filled to overflowing by heavy tropical showers if it had not been tightly capped by the little mother.



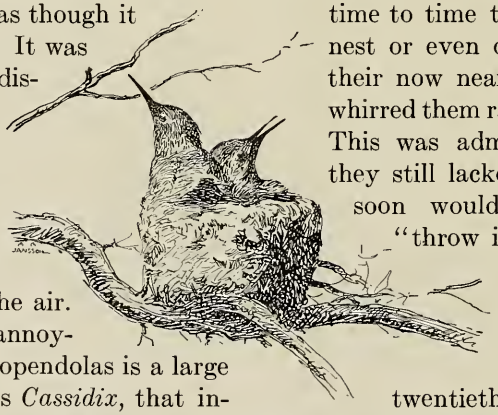
On February 9 it was evident that she had won her reward for there were young in the nest. Within a week the tips of their bills could be seen above the felted rim of the nest. With a glass one could now watch the remarkable process by which a humming-bird, after plunging her stiletto-like bill into the throat of her young, almost to the hilt, pumps predigested food well down its digestive tract.

By February 20 the entire length of the young birds' still surprisingly short bills could be seen resting on the edge of the nest, and they turned their heads from side to side with an obvious awareness of their surroundings. Doubtless they left the nest within four or five days; but here, unfortunately, my observations for the season ended. Not once during the thirty-five days of my observation did I see the father of this family. True to the habits of his kind, he had apparently deserted his bride on their honeymoon. He had, I am sure, the sympathy of the oropendolas, and at the best, there seemed to be no room for him in the family circle.

In January, 1927, when I returned to Barro Colorado to continue my studies of the oropendolas, I saw with regret that the long, bare limb, on which the hummers nested, had fallen. But from time to time I saw a female violet-throated humming-bird pursuing the oropendolas, and I concluded that somewhere in the great tree she had a home. The tree was now fully foliaged, and to find a humming-bird's nest within its innumerable branches seemed beyond the bounds of possibility. Nevertheless, with the aid of a 24-power binocular, mounted on a tripod, I determined to examine it systematically. The search began on January 19 and it ended the minute it began, for the first sweep of the glass revealed the bird seated on her nest. She had selected the nearest branch to the one that had fallen. Whether I was looking at my friend of the preceding

year I shall never certainly know. But the fact remains that the same species was nesting in nearly the same place and at nearly the same time. Furthermore, the oropendolas will testify that she acted in nearly the same way!

My notes show that she was attending to her duties day after day, with an occasional foray into oropendolum by way of relaxation, until January 29, when the record reads: "The hummer's nest has disappeared. I cannot find the slightest trace of it or of the bird herself." I could not explain her disappearance, but whatever may have been its cause, it did not prevent her or one of her kin or kind from returning to the sand-box tree in 1928, and building a nest on (as nearly as I could tell) the same limb occupied in 1927. For the third successive year, therefore, a violet-throated humming-bird nested in essentially the same place at practically the same time. It looked very much as though it were the same bird! It was January 11 when I discovered the female building, and this year nothing prevented me from following the growth of her family until its members took to the air.

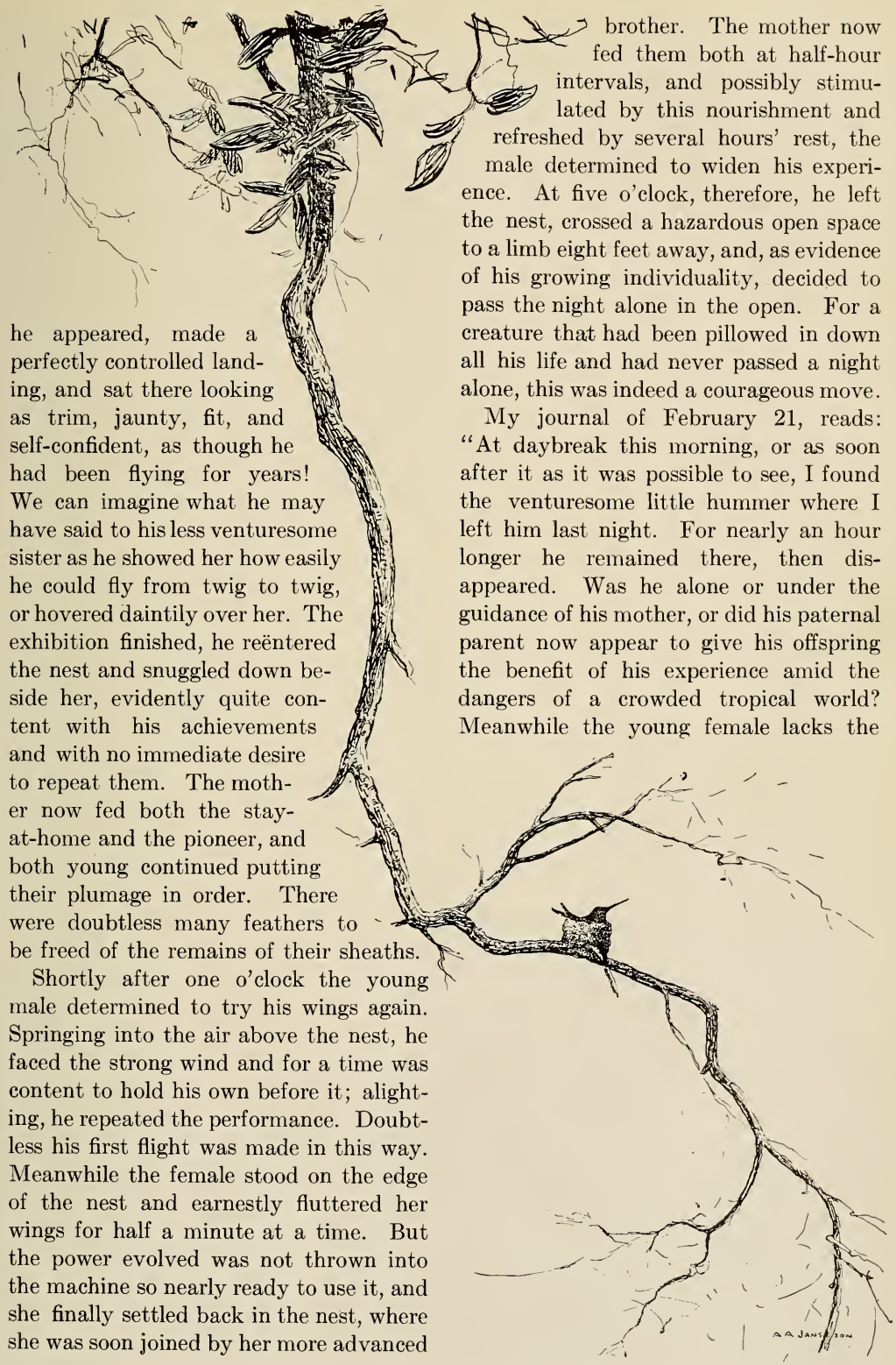


One of the most annoying enemies of the oropendolas is a large cowbird of the genus *Cassidix*, that insists on depositing her eggs in their nests. She is wholly without shame and, when her wants are pressing, only the combined forces of the oropendolas prevent her from gaining access to their homes. It was in such an emergency that the violet-throated hummer first showed a feeling of responsibility as a member of the sand-box tree community. Although both she and her nest were beneath the notice of *Cassidix*, she attacked the blackbird with marked virulence, often driving her not only from the vicinity of her home but continuing the pursuit until the would-be parasite was forced to leave the tree.

January 12 the hummer added the last touches to her nest, and two or three days later, without loss of time, she concentrated her boundless energies on the task of incubation. I have no record of the day her twins appeared, but on February 3 the tops of their heads were first seen above the edge of the nest. A week later their bodies filled the nest and they were so well feathered that, after feeding them at sunset, their mother left them for the night.

By February 16 the nest was not only filled but overflowing with young hummers. They were alert and observing, and passed much time in preening their plumage, as though they were oiling their engines before taking flight. In further preparation for this great event, from time to time they stood up in the nest or even on its rim, stretched their now nearly grown wings and whirred them rapidly in a mazy blur. This was admirable exercise, but they still lacked the impulse which soon would prompt them to "throw in the clutch." The power was there, but not the courage to use it. Early on the morning of the twentieth the twins were still in the nest. The wind was high and they were tossed about as though in a stormy sea, but in the calm intervals they resumed the alar exercises that would make them master mariners in any weather. They looked as though they might "hop off" at the word "Go" and, when an hour later I returned from the forest, only one remained. While I was debating whether the missing bird had been blown off the nest during his[1] exercises, behold,

[1]The characteristics of this bird seem to warrant the use of the masculine pronoun.



he appeared, made a perfectly controlled landing, and sat there looking as trim, jaunty, fit, and self-confident, as though he had been flying for years! We can imagine what he may have said to his less venturesome sister as he showed her how easily he could fly from twig to twig, or hovered daintily over her. The exhibition finished, he reëntered the nest and snuggled down beside her, evidently quite content with his achievements and with no immediate desire to repeat them. The mother now fed both the stay-at-home and the pioneer, and both young continued putting their plumage in order. There were doubtless many feathers to be freed of the remains of their sheaths.

Shortly after one o'clock the young male determined to try his wings again. Springing into the air above the nest, he faced the strong wind and for a time was content to hold his own before it; alighting, he repeated the performance. Doubtless his first flight was made in this way. Meanwhile the female stood on the edge of the nest and earnestly fluttered her wings for half a minute at a time. But the power evolved was not thrown into the machine so nearly ready to use it, and she finally settled back in the nest, where she was soon joined by her more advanced brother. The mother now fed them both at half-hour intervals, and possibly stimulated by this nourishment and refreshed by several hours' rest, the male determined to widen his experience. At five o'clock, therefore, he left the nest, crossed a hazardous open space to a limb eight feet away, and, as evidence of his growing individuality, decided to pass the night alone in the open. For a creature that had been pillowed in down all his life and had never passed a night alone, this was indeed a courageous move.

My journal of February 21, reads: "At daybreak this morning, or as soon after it as it was possible to see, I found the venturesome little hummer where I left him last night. For nearly an hour longer he remained there, then disappeared. Was he alone or under the guidance of his mother, or did his paternal parent now appear to give his offspring the benefit of his experience amid the dangers of a crowded tropical world? Meanwhile the young female lacks the

initiative to leave the nest and without the incentive of her twin's example her launching will doubtless be still further delayed."

Two hours after this was written the young adventurer came home. For a quarter of an hour he did his best to induce his sister to enter the world with him. First he used suasion, standing on the edge of the nest and "racing" his wings. This having no effect, he employed force, poking his sister's neck and body with his bill, pulling her wing and sparring with her. But his efforts being of no avail, he settled down in the nest and crowded her to the opposite side.

It might be imagined that the male's action was designed to make a place for himself in the nest, but no similar passage had been seen between the two young birds before, and during part of the time that he was so energetically prodding his sister, she was perched on the opposite wall of the nest, leaving its center free for his occupancy had he desired to use it.

After an hour's rest and two good meals from his mother, the young male set out in search of further adventure, and his sister, after being crowded for days, stretched herself out to enjoy the whole nest. But in the evening she was called upon to share it again. At 5:30 her wandering brother returned, claimed his share of the now much worn nest, and after they had been fed by the ever attentive mother, they settled down for the night.

They had not arisen at sunrise the following morning, but an hour later the male left his bed for a near-by branch, where he could more easily make his toilet. This completed, with much nervous twitching of the tail, betraying the forces within, he arose and fluttered over his ultra-cautious sister. Then like a dart he was off to the forest, perfect master of the delicate mechanism which makes a hummer's flight, with its abrupt turns, its sudden stops, its aërial dancing, a marvel of dashing but controlled movement.

Meanwhile the weak sister bided her time; when her brother perched at her side, she stood on the rim of the nest and made a brave effort at flight; but it was all a gesture, and when he had gone, and with him the inspiration, she sank comfortably back in the nest. But she could not deny the call to wings much longer. When next she "raced her engines" something happened, and suddenly she found herself perched on a twig above the nest. It was not a very long flight, only about six inches, but it was a flight and it was both convincing and encouraging.

After a rest of fifteen minutes and a general survey of her new surroundings, she ventured ten inches farther to windward and perched again. It was a short flight, but it had the important elements of starting and stopping; both were made with the skill of a veteran and, evidently flushed by success, the little aviator sat there looking very sprightly and quite self-satisfied with her achievement, even if she was three days behind her brother. With unaccustomed freedom she now gave her plumage a thorough overhauling from the foothold of a firm if widely swinging branch. But this important operation was abruptly interrupted.

With complete disregard of the law of trespass, a male trogon alit above the nest and began to sound its mournful note, wholly ignoring the heir to this territory who, from her perch not three feet away, regarded the intruder with unconcealed surprise. Preening was suspended, and the tiny bird, with bill inquiringly pointed at the stranger, was all attention. She was meeting her first bird outside the members of her own family and at the same time learning that if you want your rights in this world you must get them for yourself. But what could a midget hummer, with only sixteen inches of flying experience, do to expel a bird thirty times or more her

size? Nothing; she could only sit and wonder with that sharp little bill pointed upward at the huge creature. But she was far from being without a champion. From the air a small dark object hurled itself at the trogon and with equal speed swung back again. Vainly the large bird swayed and ducked; at the fifth attack he seemed to be fairly knocked from his perch. It was evidently a glancing blow, for the fury of the fiery little creature carried her past the trogon toward the baby hummer who, swept from her perch, either by a direct hit or the brush of her mother's wings, disappeared below. In a moment the mother returned, perched on the edge of the nest and, for the first time since the eggs were laid, found it empty. She remained for only two or three seconds and was off, perhaps to search for the victim of her own maternal aggressiveness.

It seemed impossible, however, that the delicate little creature could have survived. Even if she had not been struck by her impetuous mother, she was far from prepared to save herself from the innumerable dangers of the world into which she had so suddenly been forced.

But I evidently underrated both the physical and mental powers of young hummers. That evening both brother and sister returned. One, probably brother, sought a perch some thirty feet from the nest, the other came to within three feet of her birthplace. The faithful, and doubtless greatly relieved mother flew from one to the other, feeding each in turn and copiously.

At sunrise the next morning they had gone; nor did I see them again. But the end was not yet. On March 12, that is, just sixteen days later, the mother returned to the nest and started a second family! Meanwhile, unobserved, she had renovated the old home and added new material to its walls. What an exhibition of exhaustless, irrepressible vitality!

On March 24 she was still sitting. Here my observations for the season came to an end, but if, as I believe, twins appeared within a day or two, it is obvious that their mother is not so completely separated from her mate as his apparent absence during the preceding sixty-seven days would lead one to believe.

"ROBINSON CRUSOE'S CHILDREN"

The Strange Story of Nine English Mutineers Who, More Than a Hundred Years Ago, Took Up Their Abode With Their Native Tahitian Wives, on a Desert Island in the South Seas.—The Life and Heredity of the Descendants of These First Settlers on Pitcairn and Norfolk Islands

By H. L. SHAPIRO
Assistant Curator of Physical Anthropology, American Museum

ON two remote South Sea Islands, Pitcairn and Norfolk, dwell the descendants of the notorious mutineers of the "Bounty." With only intermittent contact with the outside world, this two-fold colony has maintained its integrity for almost 140 years. The physical anthropologist could not ask for a more interesting group with which to work.

The history of the Norfolk and Pitcairn Islanders goes back to the Eighteenth Century when Bligh, in command of the "Bounty," sailed from England on a botanical voyage to the South Seas. His mission was the result of petitions from the West Indian planters to the British Government that the widely heralded breadfruit of Polynesia be transplanted to the West Indies, where it might serve as an easy source of food for the plantation slaves. In October, 1788, ten months after leaving England, the "Bounty" reached Tahiti.

Even in these days of short and comparatively luxurious voyages, it is easy to imagine the great delight of the sailors on landing at one of the pleasantest of the South Sea Islands, where both Nature and the natives were kind. Bligh, in his journal published some years later, speaks of the rapidity with which each sailor soon had his particular "tyo" or friend, who acted as host during their stay at Tahiti.

After six months spent in collecting breadfruit and other indigenous plants, Bligh set sail from Tahiti in April, 1789. The partings were long and melancholy, and it was with evident reluctance that the crew set their sails to the breeze which was to carry them away from the scene of six happy months. Added to the discontent engendered by these farewells, was the familiar harshness of Bligh. One of the sufferers from Bligh's behavior was Fletcher Christian, the mate, who on several occasions had felt the lash of his captain's tongue. We can never know the true cause of the mutiny, but we may guess that the resentment of Christian found a ready response in the crew, discontented with their master and at leaving Tahiti.

Early on the morning of the 28th of April, the "Bounty" was in the neighborhood of the Tongan or Friendly Islands, when Captain Bligh was forcibly awakened by several armed men and discovered that he was a prisoner on his own ship. In his journal he recorded that he was entirely unaware of any mutinous feelings among the sailors, and from other evidence it seems that the mutiny was spontaneous. All Bligh's efforts at persuading the men to give up their design were unavailing. At each attempt he was ordered to hold his tongue or he would be a dead man. Eighteen of the crew who were not in the plot were also taken prisoners, and the Captain and his faithful men were put adrift in a small boat weighted down almost to the gunwales. Only scanty provisions, consisting of 150 pounds of bread, 32 pounds of pork, 6 quarts of rum, 6 bottles of wine, and 28 gallons of water, were furnished.

Whatever our estimate of Bligh's personal character may be, we must grant him the great qualities which he exhibited in this difficult situation. In a crowded, under-provisioned boat, he determined on the bold plan of sailing for Batavia in the East Indies, where he could expect to find a haven and assistance. His voyage of 3000 miles, completed in forty-six days, over uncharted and dangerous waters, has remained to the present day a classic in navigation. There were other hardships which almost defeated Bligh. Hunger, raging thirst under the tropical sun, and attacks from hostile natives soon weakened the resistance of the men who looked to Bligh for guidance. He did not fail them, although he was forced to use drastic methods to save the men from themselves.

Christian, at the head of the twenty-five mutineers, now returned to Tahiti, where they accounted for Bligh's absence with the story that he had met with Captain Cook, and that the "Bounty" had been sent back for more supplies. After several unsuccessful attempts at establishing a colony on a near-by island, Christian and the mutineers returned to Tahiti, where they separated into two parties. Sixteen of the men preferred to remain at Tahiti where they very soon set up menages. The other nine, anxious to find an inaccessible island where they might be safe from a punitive expedition from England, left Tahiti, taking with them about twelve native women and six native men.

When Captain Edwards of the "Pandora," sent to capture the mutineers, reached Tahiti a couple of years later, nothing was known of the fate of Christian and his men.

Not until 1808 was a trace of the missing men discovered. In that year Captain Mayhew Folger of Boston was

Photograph by Rollo H. Beck

PITCAIRN DWELLING

In the early days the planks were laid vertically, unlike those in this picture. Considering the isolation of the island, it is interesting to note the use of corrugated iron. Thatching with pandanus leaves was derived from Tahiti

very much surprised to find himself hailed in English by the children of the mutineers when he touched at Pitcairn, which he believed to be uninhabited. He learned from the sole surviving male, John Adams (formerly Alexander Smith), that on reaching Pitcairn in 1790 the "Bounty" was destroyed so that there might be no defection. Each of the nine sailors received an equal allotment of land.

Owing to the treatment which the native men received at the hands of their white companions, they soon rebelled. Dissension among the sailors on account of the women and fighting with the native men led to a series of horrible and brutal crimes, which ended in the murder of all the native men and all but four of the sailors. Of these, M'Coy, who in his youth had worked in a Scotch distillery, discovered the intoxicating qualities of a distillation of the ti plant. It was reported that he jumped over a cliff in a drunken frenzy.

Quintal was murdered by Young and Adams in self-protection. The only natural death was that of Young, who died in 1800, leaving Adams alone with the women and the children of the various unions of the sailors with the native women. Later visitors described Adams as a patriarchal figure, fathering the whole little colony, imparting his small store of learning and religion, and prescribing the line of conduct to be followed by his charges.

So unexpected and dramatic was the idyllic life of the Pitcairn Islanders after the violence which attended its establishment, that this remote island and its inhabitants served many a preacher for a text on the beauties of a Christian life. Rare copies still exist of a small pam-

THE "RESOLUTION" AT NORFOLK
This boat, recently completed in the expectation of a lucrative fruit trade with New Zealand, is the most ambitious ever built on Norfolk

Photograph by Rollo H. Beck

CHURCH ON PITCAIRN

This is the largest structure on Pitcairn and was built about seventy-five years ago. It is now used as a church and community meeting house, as well as a schoolhouse

phlet distributed among American Sunday Schools early in the Nineteenth Century which related the story of the Pitcairn Islanders for the edification of young readers.

Except for the rare arrival of a ship, the calm of Pitcairn was unbroken. In 1831 the islanders made an attempt to establish themselves on Tahiti, where they might have more room for expansion. This ended in disillusionment and a return to Pitcairn. Nothing more was done about the dread of overpopulation, which motivated the move to Tahiti, until 1855, when they petitioned the British Government to remove them to Norfolk, which was being abandoned as a penal island. Consequently in 1856 the whole community was transferred to its new home on Norfolk, where for the first time they saw stone buildings. Although Norfolk is considerably larger than Pitcairn, and its beauty attracted many of the islanders, some of the colony were homesick for Pitcairn. After a few years several families returned to Pitcairn, where their descendants still live. But the principal group still dwells contentedly on Norfolk. Some years afterward, against the wishes of the islanders, the Melanesian Mission established a station on Norfolk, but recently it was abandoned.

Life on Pitcairn was largely dependent on the fruits and crops of the island. In later years chickens and cattle were added to the resources of the colony. From the nature of its beginnings the colony was, in a sense, a sociological experiment. The sailors found themselves in a *milieu* which was utterly different from their own environment, and they were forced to make use only of the materials which they could secure on the island.

The only men of education and learning died or were soon murdered. John Adams

Photograph by Rollo H. Beck

MEETING THE SHIP

The Pitcairn Islanders are excellent boatmen. They are shown here following their usual custom, coming out to meet a newly arrived ship

A WHALE ON THE SHINGLE

Whaling is still an important industry on Norfolk from July to October. Great strips of blubber are hauled up on the shore by a team of horses to vats where the oil is extracted

Photograph by Rollo H. Beck

THE FIRST HOME OF THE MUTINEERS

Pitcairn is a small, precipitous, volcanic island, first discovered by Carteret. It is covered with luxuriant tropical foliage

Photograph by Rollo H. Beck

HISTORIC LANDING PLACE AT PITCAIRN

Landing at Pitcairn is extremely dangerous, but the islanders are skillful in maneuvering the boats so that, riding on the crest of a wave, they are able to make a safe landing

DEDICATION OF A NEW CHURCH
The church was built by the Norfolk Islanders through the inspiration and devotion of "Uncle" Cornish (the bearded man)

was almost illiterate, tracing the meanings of words with great difficulty, and he had no knowledge of government or law. Consequently it is remarkable to trace the development of a workable code of self-government and conventions. Almost from the beginning the women had an equal share with the men in the election of the officials who took over the guidance of the colony after Adams' death in 1829. Property was inherited alike by all the children regardless of sex. Education was compulsory up to the age of sixteen. This consisted in learning to read, write, and cipher, with a greal deal of Biblical history. For a time there was a communal fund of food to which all contributed. Later, when trading assumed greater proportions, definite regulations were adopted to govern the methods and standards of exchange.

The houses were built in an original fashion. The planks were placed vertically in grooves cut into large timbers which made the frame of the house. Some were two stories in height and were grouped about a central commons. The clothing was made by the women from tapa manufactured according to Tahitian methods, although later they were able to secure clothes from whalers and others who visited them. The manner of cooking was very reminiscent of Tahitian cooking. A whole pig would be baked in a pit dug in the ground and covered over with a mat of leaves.

One of their most interesting contacts was with the New England whalers who swarmed in the Pacific in the middle of the last century. Many of the young men shipped on long cruises, returning with Yankee tricks of speech and customs. Frequently the captain would leave his wife at Pitcairn to be picked up on the return voyage. During such visits these efficient New England housewives in-

troduced many innovations, so that even at the present time pie is a favorite dish. During my stay at Norfolk I was the guest at a Thanksgiving dinner at which all the traditional dishes were served.

One of the most valuable things inherited from the whalers is the technique of whaling. On Norfolk, whaling is still practiced and is a lucrative source of income.

Since the necessities of life on Norfolk and Pitcairn are few, the principal occupation is raising sufficient food to supplement the wild fruits that grow abundantly. An additional source of income on Norfolk is the preparation of lemon juice, which is shipped to Sydney, Australia.

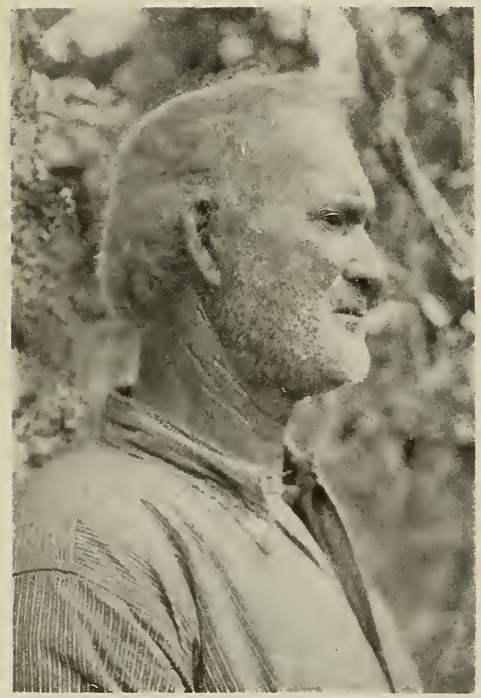
For entertainment the Norfolk Islanders are dependent on European games and amusements. Tennis is a favorite form of sport, and a tournament is held annually for a shield. Cricket, football, and horse racing are also popular. More sedentary games such as checkers, cards, and chess, find enthusiastic devotees. During my visit a weekly dance was held, which attracted all the younger people. Also once a week a moving picture show was given. The social life of the islanders is very hearty and informal. Moonlight picnics, garden parties, and other gatherings of a social nature are always hilarious. A strong love of music is common, and one of the most generally attended organizations is the choral society.

The Australian Government maintains a doctor on the island, and the school, which is free, is attended by all the children. An administrator represents the Australian Government, but the islanders are allowed to manage their local affairs through a body of elected officials. Taxes are paid in the form of public work, which consists in building roads and repairing public buildings.

Most of the islanders are affiliated with

THANKSGIVING ON NORFOLK ISLAND

This holiday is celebrated on Norfolk with a feast and church service. Flowers, fruits of the field, and domestic products are exhibited and used as decorations in the church



NORFOLK TYPES

These individuals belong to the fourth and fifth generations from the original English-Tahitian cross. English as well as Tahitian characters reappear in these types

NORFOLK TYPES

Note the strong Northern European appearance of the girl at the lower left. The woman at the lower right represents the Tahitian type

LUNCHING AL FRESCO

Picnics are popular on Norfolk. "Uncle" Cornish, the benevolent guide of the author of this article, is shown here. He is a grandson of Matthew Quintal, a mutineer

the Church of England, but other denominations such as Methodist, Seventh Day Adventist, and Baptist have adherents. Pitcairn, however, is now almost entirely Seventh Day Adventist. The principal church on Norfolk is a large Georgian building of gray stone which is a relic of the penal colony. On alternate Sundays the congregation meets at the former chapel of the Melanesian Mission station, which is beautifully decorated with mother-of-pearl, inlaid in Melanesian designs, and has a number of beautiful stained glass windows designed by Burne-Jones.

The present population is approximately 600 on Norfolk and more than 175 on Pitcairn. Many of the younger members of the community have in recent years sought wider opportunities on the mainland, where they have married and settled, so that the total number of living descendants of the mutineers is probably more than a thousand.

To the anthropologist, the chief interest of the descendants of the mutineers of the "Bounty" lies in the fact that here is an example of race mixture between two contrasted races. In studying race mixture it is always discouraging when one attempts to define the ancestry precisely. Where the mixture has been long continued, it is frequently hopeless to obtain satisfactory genealogies. The Norfolk Islanders, however, have kept records of marriages and births, so that I have been able to make for all the islanders genealogical tables which go back to the original cross, and in that way determine the proportions of Tahitian and English in the population. There is somewhat more English "blood" in the present generation. In studying the qualitative characters such as eye color, skin color, and hair form and color, one finds among these hybrids evidence of genetic behavior along Mendelian lines. The typical phenomena of dominance and segregation have taken place. In a small proportion the recessive traits such as blue eyes, blond hair, and fair complexion, are combined in one individual. An example

of this type is shown on page 299. On the other hand, one finds, according to expectation, a number of individuals who are strikingly Tahitian in appearance. On the whole, Tahitian and English characters form a mosaic, the totality of which in some tends toward the English and, in others toward the Tahitian. Heterosis or hybrid vigor, which is frequently observed in the first generation after the original cross, is well illustrated in the stature of the Norfolk Islanders. Early records indicate that the hybrids in the first generation were considerably taller than either Tahitian or English. Although this excessive stature has diminished among the Norfolk Islanders, it is still greater than that of the parent stocks.

From necessity the islanders have inbred from the beginning, so that now after five or six generations, everyone is related to the rest of the community. In some cases the degree of blood relationship between husband and wife is extremely close. Yet there are no evidences of deterioration. On the contrary, the Norfolk Islanders are tall, muscular, and healthy. That inbreeding mysteriously produces degeneracy is now disproven by animal experimentation. Among the Norfolk Islanders we have another example that inbreeding in a sound stock is not attended by the traditional stigmata of degeneration.

Vital statistics reveal some interesting physiological facts in the hybrids. In the second generation the average number of children per family was 9.1. This average is greater than in any other generation. In the same generation the average age at marriage was 16.8 years for the women and 20.9 for the men. In later generations these ages increased. This high point in fertility exceeds the fecundity even of the Rehobother Bastards studied by Fischer.

Although there have been several additions of Europeans to the Norfolk community, their influence has been relatively slight. One can only hope that this fascinating group may be allowed to maintain its identity and continuity.

Photograph by Rollo H. Beck

A BOATLOAD OF PITCAIRN ISLANDERS

These men are sturdy members of the subsidiary colony now living on Pitcairn, where they number more than 175

Mayon, a volcano of the Philippines, 7916 feet high and 120 miles in circumference, rises from a plain to form a perfect cone. For centuries its vapors gave forth a fiery glow at night, but now all is quiet. There were 26 eruptions in the Nineteenth Century, those of 1814 and 1897 being of great violence. The last important outbreak occured in 1900. In all probability the next eruption will be exceptionally violent

VOLCANOES IN ACTION

By CHESTER A. REEDS

Curator of Geology and Invertebrate Palæontology, American Museum

With Eleven Photographs and Captions by Dr. F. A. Perret, Volcanologist

THE eruption of a volcano is perhaps the most impressive and awe-inspiring phenomenon known. The stupendous releasing of matter and energy, the unhurried modulation of its periodic beats, the seismic pulsing of the ground, and the exceedingly rapid undulations of electric flashes in the cloud of ash, produce not only a sublime manifestation of rhythm, but of infinite dignity. Perret, in 1924, writes: "No words can describe the majesty of its unfolding, the utter absence of anything resembling effort and the all sufficient power to perform the allotted task and do it majestically." The immensity of these forces, the magnitude of the results achieved, and the disastrous consequences, which an eruption frequently entails, impress the human mind with the vast amount of dynamic energy pent up within the earth.

The sixty-six active volcanoes scattered over the surface of the earth are not in maximum eruption every day. Judging from their known histories, it is apparent that each volcano acts more or less independently of the others, and that the activity of most of them is intermittent with paroxysms of greater or lesser violence occurring after intervals of comparative, or even complete, repose. Stromboli, one of the Lipari Island volcanoes, has been characterized by a moderate, though somewhat constant activity during two thousand years. To mariners it is known as the "lighthouse" of the Mediterranean. If the period of quiescence has been long, the renewed activity of a volcano is apt to be exceptionally violent. For instance, Krakatoa, near Java, had been dormant for about two centuries before the great eruption of 1883. It is reported that Bandaisan, the Japanese volcano, was silent for more than one thousand years before the tremendous outburst in 1888.

One of the greatest of volcanic eruptions in recent years was that of Sakurajima in southern Japan. This volcano, with a cone shaped very much like Vesuvius, rises to a height of 3506 feet. Previous eruptions of this volcano had built up a circular island about seven miles in diameter in Kagoshima Bay, and upon it there were eighteen villages with an aggregate population of 22,000 farmers and

Photograph by F. A. Perret

THE CRATER CLOUD OF VESUVIUS, APRIL, 14, 1906

Interior avalanches of crater material caused great clouds of gas and ash—half a mile in diameter—to rise in majestic spiral curves during the closing days of the 1906 eruption

Photograph by F. A. Perret

AN EARLY PHASE OF THE GREAT ERUPTION OF VESUVIUS, 1906

The emission of gas and ash from the pulsating volcano was like the puffing of a gigantic locomotive on a heavy grade. The white vapors are from lava that issued from near the base of the cone

fisher folk. Two miles of water lay between the western margin of the volcanic island and the shore of the larger Kyushu island on which stood the city of Kagoshima with a population of 70,000.

The observatory of Kagoshima had recorded 91 earthquakes in 1913 as compared with only 34 for each of the years preceding. Early in January this station noted an ever increasing number of earthquakes, and between 4 A.M. of January 11, and 10 A.M. of January 12, 417 quakes were recorded, many of them strong. The situation was ominous, and due to a knowledge of the significance of earthquakes in the vicinity of volcanoes, developed in Japan since 1890, the people in this region were forewarned, and those who dwelt on Sakurajima Island were removed prior to the violent eruption, which began at 10:05 A.M. of January 12, 1914.

The first outburst of gas, steam, and ash, which was from the western vent opposite the city of Kagoshima, reached elevations between five and six miles in height. Ten minutes later a similar column rose from three crater pits on the eastern side of the mountain. Glowing bombs, hot sand, flashes of lightning, great billows of smoke, and seismic shocks waxed in fury. A terrific earthquake at 6:29 P.M. threw down walls and buildings in Kagoshima, causing the death of 35 persons, and the injury of 112, the only casualties during this great eruption. This great shock was accompanied with the outflow of lava on both the eastern and western sides of the volcano. Following these great outbursts, intense activity continued in the western craters until January 20, while in the eastern ones it persisted for several months.

Prof. T. A. Jaggar, of the Hawaiian Volcano Observatory, who has written an interesting account of this convulsion,[1]

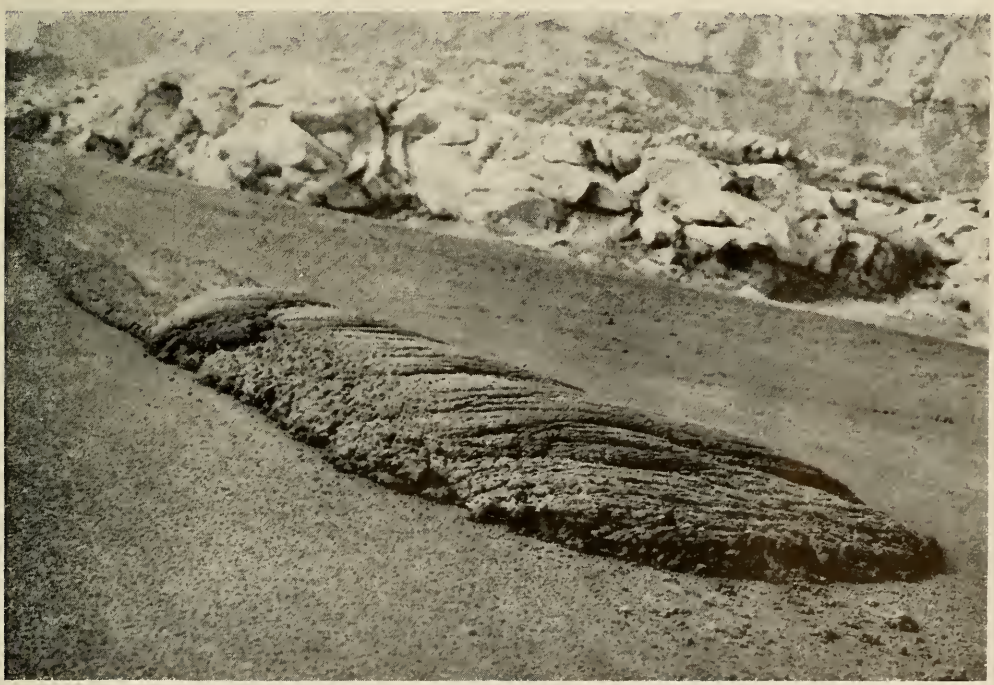
[1]Jaggar, T. A., 1924, "Sakurajima, Japan's Greatest Volcanic Eruption" *National Geographic Magazine*, Vol. XLV, No. 4, pp. 441–470.

arrived in February to witness the lava outpourings, which joined Sakurajima Island to the mainland of Osumi, while Dr. F. A. Perret, volcanologist, witnessed during February and March the big eruptions from the eastern craters. The resulting ash deposits, which were six feet in thickness near the volcano, thinned down to a mere film thirty miles away, while more than four thousand acres of hard lava were poured out during the first two months of the eruption.

Careful levelings after the eruption showed that old bench marks at the base of the volcano had been upheaved twenty-four feet, while the land all around for a distance of seventy-five miles had subsided, due to the withdrawal from the depths of the earth of the great volumes of ash and lava.

The most outstanding feature of this great volcanic outburst is that no lives were lost except those resulting from a severe earthquake. The ravages of the eruption were also minimized due to the application of scientific knowledge concerning the catastrophe.

The volcanoes which emit lava in greatest volume are comparatively quiet in their action. This is the case with the volcanoes of Iceland and Hawaii, which erupt dark basaltic lavas. Eruptive cycles have been recognized in this type of volcano in Mauna Loa, 13,900 feet high, and Kilauea 4000 feet above the sea, both on the island of Hawaii. Kilauea, being at a lower elevation, is more readily reached than Mauna Loa, and since Prof. T. A. Jaggar established a volcano observatory there in 1911, its action has been studied more closely than that of any other volcano in the Pacific Ocean. Kilauea was discovered in 1823, and except for widely separated intervals of short duration, a "lake" of molten lava is reported to have occupied the central portion of the crater



Photograph by F. A. Perret

THE TERMINUS OF A "MUD LAVA" FLOW

On the upper slopes of a volcano, rain water may seep into fine ash and form a liquid mud. This is much feared after an eruption, for oftentimes it is very destructive

Photograph by F. A. Perret

THE SAKURAJIMA ERUPTION, 1914

Ash clouds of the "cauliflower" type rose to great heights, and houses were buried up to the eaves by this ejected material. Vast quantities of lava also flowed into the sea

Photograph by F. A. Perret

ASH AND STEAM EMISSION AT THE CRATER OF STROMBOLI

From a small but very persistent vent on the east rim of the crater much ash is carried up and can usually be seen falling in showers from the edge of the cloud

Copyrighted Photograph by F. A. Perret

AN ISLAND IN A "LAKE" OF MOLTEN LAVA

The Halemaumau pit in the crater of Kilauea volcano, Hawaii, was filled for many years with a "lake of fire." The hardened lava in the center lasted for several months

until 1894. When first observed in 1823, there was a great pit 1700 feet deep, known as Halemaumau, but subsequently the molten lava rose and frequently welled over the confining walls to stream away over the adjacent crater floor. These repeated upwellings gave rise to a low, flat cone in the region of the central "lake."

The almost continuous activity of this volcano suffered a check, however, in July, 1894, when, with a series of local earthquakes, the molten lava fell rapidly to a great depth in the Halemaumau pit, and by December, 1894, the molten lava had disappeared entirely. It reappeared for short periods prior to 1907, when it resumed a continuously active condition until May 1, 1913. The dormant interval, 1894 to 1907, is of interest in the study of eruptive cycles.

The molten lava, which disappeared into the depths of its pit in May, 1913, reappeared in October, 1913, forming spatter cones, boiling pots, and areas of overflow, at the bottom of the pit. Then it gradually raised its surface in a fluctuating way until October, 1914, when a molten "lake" again appeared. This condition, with fluctuations in height and vigor of surface action, prevailed until May, 1924, when Kilauea exploded. This event according to Professor Jaggar[1] came near the end of a cycle that began in 1913. The cycle reached its culmination with lava outpourings on both Mauna Loa and Kilauea, and declined after 1919 with a succession of sudden lava sinkings and enlargements of the Halemaumau pit. Since 1924 prolonged quiet has ensued.

The amount of rock removed by the May, 1924, explosion, as noted by Professor Jaggar, was 28 million cubic feet, while that removed by engulfment was

[1]Jaggar, T. A., *Bulletin, Hawaiian Volcano Observatory*, Vol. XII, No. 12, pp. 117-122, December, 1924.

Photograph by F. A. Perret

TELEPHOTO VIEW OF THE ISLAND SINKING INTO LIQUID LAVA

Frank A. Perret, the volcanologist, leaned far out over the edge of the Halemaumau pit, Hawaii, to secure this detailed record just before the island sank below the surface of the lava lake

253 times as great. The crater pit was enlarged fourfold not by the attrition and ejection due to gas rushes, but by collapse of the walls into a void below, just as it was enlarged by collapse in 1913, 1918, 1919, 1920, 1921, greatly in 1922, and again in 1923, all without explosions. The May, 1924, explosive eruption was thus merely an incident in a mechanism of engulfment. This event increased the depth of the pit from 400 feet to 1000 feet, and it has been calculated that the shaft, which would hold the rock that was engulfed, must be 8000 feet in diameter and more than 3000 feet deep.

The eruptions of the volcanoes Soufrière and Mont Pelée in the islands of St. Vincent and Martinique, respectively, on May 7 and 8, 1902, furnished a type of activity not previously recognized by volcanologists. These eruptions were characterized by the sudden emission of dense black clouds of superheated and suffocating gases heavily charged with incandescent dust, lapilli, and "bread-crust" bombs, which rose to heights of 12,000 feet and moved swiftly down the slopes of the volcanic cones like a hot avalanche, called *nuée ardente* by Lacroix.[1] According to Perret, the conditions requisite for the formation of a *nuée ardente* are believed to be a pasty lava, very highly charged with gas and so near the mouth of the crater that it might be expelled in the forms manifested at Mont Pelée and the Soufrière. Heilprin, Fenner, and Perret have noted that it is not improbable that a *Peléean nuée ardente* happened during the Plinian eruption of Vesuvius in 79 A.D., during the Katmai volcano eruption in Alaska in 1912, and during the 1914 eruption of Sakurajima in Japan.

No streams of molten lava issued from either Mont Pelée or Soufrière in 1902,

[1]Lacroix, A. *La Montagne Pelée* (1904).

although the ancient rocks show that lava flows alternated with volcanic fragmental deposits, *tuffs*, in the early history of these mountains. The cracked condition of the "bread-crust" bombs and the unusual Mont Pelée spine, which existed in the conduit for a year previous to crumbling, show, according to Hovey, 1902,[1] that partially melted masses of gray andesitic rock existed in the throats of these volcanoes. Little is known concerning the previous activity of Mont Pelée, in 1762, 1851, and the Soufrière in 1802. There were no lava flows at those times. This fact is in harmony with an observation of Leopold von Buch, 1774–1853, that the active volcanoes in the Andes have no free flows of lava.

The deadly effect of the Peléean blasts in Martinique and St. Vincent, which killed, within a few minutes, some 42,000 people, seems to have been due chiefly to the irritation of the mucous membrane of the respiratory passages by the fine hot dust. Those persons near the Soufrière, who took refuge in cellars, and the one prisoner in the dungeon at St. Pierre, escaped with their lives.

Vesuvius, in Italy, is the world's best known and most fully studied volcano. Of the period prior to the Christian era, little is known concerning the activity of this volcanic vent. The Greek geographer, Strabo (B.C. 63–A.D. 24), believed it to be a volcanic crater, though extinct. In his day the present complex cone with its Atrium and partial Somma, did not exist, instead only the complete outer ring, the Somma. The terrific outburst of 79 A.D. was on such a grand scale that it constitutes one of the most oustanding events in the history of this volcano. The explosion was so tremendous that the greater portion of the cone, the Somma ring, was blown into bits. No streams of lava issued forth, but such a vast quantity of lapilli and ash that the city of Pompeii, to the southeast, was covered in places to a depth of 25–30 feet, and Herculaneum, to the southwest, was buried by a flood of mud and ash to a depth of 60 feet. These latter deposits have been covered by lava streams of more recent eruptions. From a study of the rocks in the Monte Somma remnant, Johnston-Lavis, 1891, determined a record of fourteen periods of eruption and two long intervals of repose preceding the Christian era.

Between 79 and 1631, eight eruptions of Vesuvius are recorded, but little is known concerning them. Except for a slight outburst of ash in 1500, there was a long period of repose, 1139 to 1631. During this interval, the crater was forested and overgrown with vines, as it had been for a long time previous to 79 A.D. Following this long period of repose, a great explosive eruption occurred in December, 1631. This outburst began on December 15 with rumblings within the crater, followed by an opening of a cleft upon the east side of the mountain, and the emission of steam and ash. On the following day, another fissure opened on the south side, from which steam and ash burst forth to overwhelm four nearby cities. On the 18th, four great streams of lava poured from the crater, three of them reaching the sea. Eight towns were overrun by these lavas and 3000 persons lost their lives. This eruption reduced the height of the cone by 170 meters.

Since 1631 five major eruptions have occurred, namely: 1737, 1794, 1822, 1872 and 1906; also ten minor emissions, to wit: 1834, 1839, 1850, 1855, 1861, 1878, 1899, 1903, and 1913. During this period of almost 300 years a more nearly continuous form of activity has prevailed with explosive and effusive factors more nearly equal in proportion. The conduit of Vesuvius remained open throughout most of the time intervening between

[1]Hovey, E. O., 1902. Martinique and St. Vincent, A Preliminary Report upon the Eruptions of 1902. *Bull. Amer. Mus. Nat. Hist.*, Vol. XVI, pp. 333–372, 18 plates.

Copyrighted Photograph by F. A. Perret

THE BURSTING OF A GAS BUBBLE

In the active liquid lava lake of Kilauea, there will often rise from a vent at the bottom a swarm of great gas bubbles. These rise rapidly to the surface, lifting the heavy, incandescent liquid in a boiling dome of exquisite beauty, throwing out scattering jets, and sending blue-green flames into the air. This is "Old Faithful," more than thirty feet in height

these later eruptions, thus causing a diminution and virtual elimination of the severe seismic disturbances which formerly, at the time of an eruption, affected the immediate region so disastrously.

The 1906 eruption of Vesuvius is of special interest not only because it passed through three phases of an eruptive cycle, but since it was carefully studied by the officials of the Vesuvian Observatory one of whom, Dr. F. A. Perret, an American, has written a full account of those eventful days.[1] Other volcanologists, chiefly French, German, English, and American, have also described this activity; hence, it is one of the better known of the Vesuvian eruptions. It would be a pleasure to give here an extended review of Perret's work, but the allotment of space permits only an abridged account of the three phases of activity.

First Phase.—Following a progressive fissuring and demolition of the upper portion of the cone on April 4, molten lava issued from the side of the crater and the ash cloud rising from the volcano in fairly dense, dark volutes, assumed a threatening aspect. The crater-cloud, carried over the city of Naples and nearby towns, produced a rude awakening to the seriousness of the situation. Neapolitans on the 4th and 5th went about with umbrellas opened against a dry rain of coarse, grayish-black volcanic sand.

The volcano presented an imposing spectacle, not unlike that of a gigantic locomotive puffing up a heavy grade and being constantly supplied with fresh fuel. The eruptive material of these first days

[1]Perret, F. A., 1924, "The Vesuvian Eruption of 1906," Publication No. 339, *Carnegie Institution of Washington*, pp. 1–151.

was coarse in texture and dark in color, consisting mostly of cone detritus. The product was spread in many directions, some towns receiving an average of 90 centimeters, others 30 centimeters. Had the ash been deposited in one direction, that sector would have been buried more completely than was Pompeii in 79 A.D., which was spared this time.

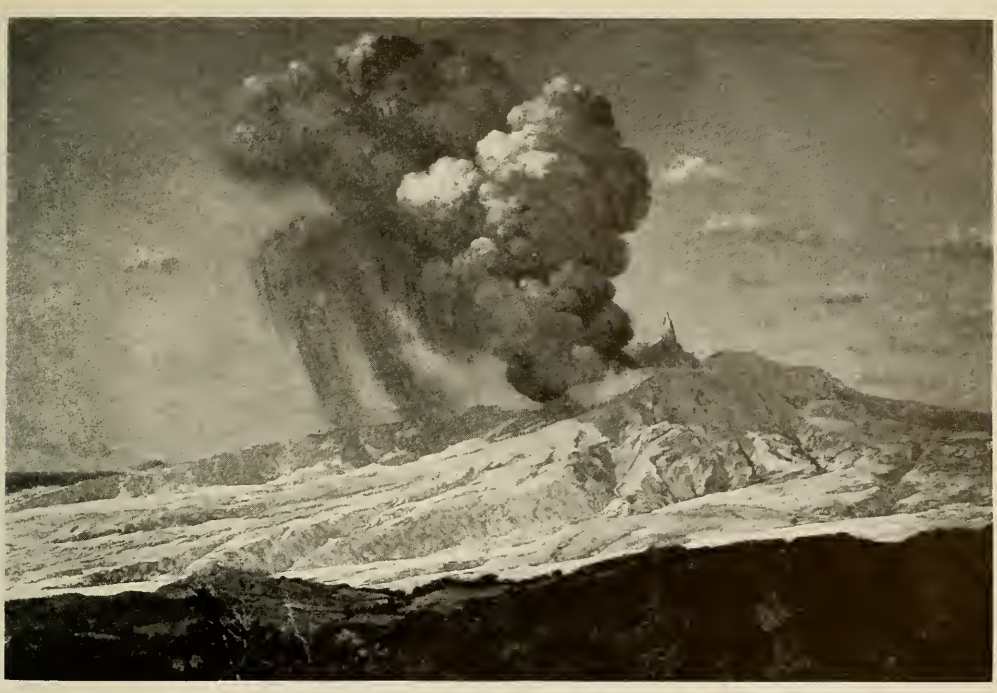
Great flows of lava continued throughout the night of the 5th, and on the morning of the 6th a new lava vent was formed, which gave forth a very rapid outpouring. The activity in the crater also increased to an even greater degree than on the preceding day. The ash of April 6 was of a much finer texture than any hitherto emitted, and the electrical discharges in the crater-cloud were also longer and far more powerful, with an occasional reverberation like ordinary thunder. By midnight all the phenomena had increased in intensity, with sure and repeated demonstrations of greater gas-content in the magma and progressively more active gas-release from the volcano. The magma, which had formerly occupied a lower level in the throat of the volcano, now rose to take the place of that which had been emitted. Nothing could be clearer than the thrice repeated revelation of a rhythmic uplift of magma to higher levels, pulsing in surges of ever increasing amplitude, with consequent liberation of their stored-up energy in the production of the dynamic paroxysms. The instruments at the Vesuvian Observatory continued to indicate seismic activity of constantly increasing magnitude.

On April 7 the dynamic activity at the crater took the form of a series of very sharp, sudden, but powerful explosions in rapid succession, there being at times as many as three per second, with an average of one every two seconds. The material ejected was of a mixed nature, about equally divided between fresh liquid lava and the dark detritus of the crumbling cone. At the instant of each explosion a luminous arc would flash upward and outward from the crater and disappear into space. This phenomenon may be considered one of the most beautiful of all volcanic manifestations.

From time to time there were great explosions having a tearing and roaring sound, "*the boati*," with sensible air-concussion, and the panic among the inhabitants of the Vesuvian towns was great. At night, masses of cone-material were mixed with the incandescent jets, while brilliant electrical discharges pierced the dark detritus clouds. At times, the pillar of liquid fire, maintained at a height of several kilometers, would illuminate the Gulf of Naples from Capri to Miseno.

After midnight of the 7th there was a continuous earthquake and, for some hours, it was impossible to stand quite still. The mountain was pulsing and vibrating continuously like the shell of a humming boiler. The most alarming feature at this time was the continuous increase in the strength of the earth shocks above the regular pulsations. A second powerful earthquake at 2:30 A.M., April 8, caused great downfalls at the mountain-top, and from this moment a condition was reached where action, reaction, and interaction combined to effect a release of energy that nothing but exhaustion could bring to an end. The electrical manifestations reached an appalling intensity, and a portion of the great columns of gas, lava, and detritus was shot obliquely to the northeast, covering the cities of the plain with ash to a depth of three feeet.

At 3:30 A.M., April 8, the true dynamic culmination of the great eruption began with a literal *unfolding* outwardly of the upper portion of the cone in all directions, like the falling of the petals of a flower. The mighty uprush of gas liberated from the depths with ever increasing accelera-



ERUPTION OF MONT PELÉE, ISLAND OF MARTINIQUE, WEST INDIES
From a painting by Charles R. Knight after a photograph by the late Dr. E. O. Hovey, 1903

tion was actually coring out and constantly widening the bore of the volcanic chimney. The emanations gradually became less luminous and, with the fall from the skies of fragments of gray rocks torn from the conduit, it was necessary for one to stand erect with a rolled-up overcoat held as a cushion upon one's head. The projectiles, which varied in size from nuts to masses weighing 2 to 3 kilograms, fell as far as 4 kilometers from the crater.

Second Phase.—By daylight of April 8 the seismic movements had diminished in intensity, all the liquid lava had been ejected, and the throat of the volcano was clear, but from a source, the depth of which is unknown, there rushed forth through the central tube a continuous blast of gas, reaching heights as great as 13,000 meters. At the top of the lofty pillar of cloud great globular masses of vapor were expanding outwardly against the surrounding air-cushion with incredible velocity, forming "cauliflower heads" with a sharpness of contour and wealth of detail impossible to describe. That which staggered the imagination was the revelation of stupendous initial pressure. The ash content having been filtered out in the rapid projection of the gas upward, the upper and outer edges of the great "cauliflower" masses were of the purest white and closely resembled condensed steam.

At midnight of April 8 exceedingly powerful electric discharges with long reverberations were heard, indicating renewed injection of detritus into the crater-cloud, and, inasmuch as this could hardly have occurred under the sway of the ultra-powerful blast of gas, there was reason for supposing that this marked the end of the second or "intermediate gas phase."

The earthquakes of the night of April 7 had produced a state of panic at Naples, and it is said that 100,000 persons left the city in five days. At each return of

the crater-cloud, with its darkness and its showers of ash, processions filled the streets, invoking intercession of the saints.

Third Phase.—On the morning of April 9 an imposing volume of ash issuing from a greatly widened crater, but under a reduced gas-pressure, revealed a great change in the nature of the eruptive processes. The last and longest phase of the eruption, the dark ash phase, had arrived, and it behooved Doctor Perret, who had made a hurried trip down the mountain to Naples, to return to his post at the observatory. This he did with difficulty. On the way he saw scenes like those which Pompeii must have witnessed in 79 A.D. The volcanic storm produced darkness equal to that in a tunnel. Human faces peered from doorways, from under wagons, and from every place of shelter. About the observatory the down-sweeping ash became conglomerated with the water vapor in the crater-cloud, forming balls of soft mud, some as large as an egg.

Upon the cone itself "hot avalanches" were observed. This material, representing the accumulation of ejected material upon the upper portions of the cone, was not only intensely hot but, due to the dilated condition of the interstitial gas, and being poised in exceedingly unstable equilibrium, it possessed an extraordinary amount of potential mobility. The extensive repetition of the avalanches on the outer slopes of the cone produced numerous radial furrows, *barrancos*, which remained long after the eruptive period had passed.

On the morning of April 10 the observatory seismoscopes were quite strongly agitated. The crater-cloud was once more sent upward with some force, but in the afternoon it arched over toward the southwest, and swept down the mountain-side over Terre del Greco. The electrical discharges within the crater-cloud had ceased, but the cloud itself was strongly electrified as a whole and in opposition to the earth, to which it was powerfully attracted. Doctor Perret and his companions, in passing under this cloud of gas and ash, noted that the electrical potential was so powerful that a "brush discharge" (St. Elmo's fire) was developed on every pointed object. The electrical attraction was still further demonstrated by the violent impact of the coarse grains of sand, which scratched the skin and cut the lips to the point of bleeding. This was the manner in which Pliny, the Roman naturalist and author, died in 79 A.D. On this day the ash-cloud, the smallest diameter of which was 600–700 meters, attained probably its greatest density.

From April 11 to 21, the seismic shocks were frequent and oftentimes strong. During this time the ash fell heavily, producing a series of long periods of obscurity, some lasting for eight hours or more, in which there was absolutely no difference between night and day. The gas emissions of the 18th contained carbon dioxide. This heavy, invisible gas produced a sensation of heat about the feet and legs, indescribable oppression, and a slight difficulty in breathing.

On the 22d the eruption, dynamically, was virtually at a end, as the seismoscopes often stood motionless for hours at a time. The crater-cloud of ash and gas—though still rising majestically and in successive puffs due to soft explosions—had an ascensional power barely sufficient to raise its heavy content of ash. On April 30 all was quiet and Doctor Perret returned to Naples after having visited the rim of the great crater on April 24.

According to Perret there has been a marked periodicity in the modern eruptive process of Vesuvius, each great eruption releasing energy and material which have accumulated during a more or less prolonged period of lesser activity, in spite of occasional temporary relief through minor outbreaks. Then follows a

Photograph by F. A. Perret

BALL-HEADED VORTEX EXPLOSION FROM THE CRATER OF STROMBOLI

After a stoppage of perhaps fifteen minutes the gases burst through the plug to form a rotating vortex with gas sufficient to carry up stones. The rotating vortex at the top throws these stones in all directions

period of repose, due to exhaustion and obstruction, after which the renewed supply of magma—rising slowly from the depths—reëstablishes a vent at the bottom of the crater-basin, and a new active period ensues, completing a cycle. Mercalli, in 1907, called attention to this, and published a list of twelve such periods since 1700, each culminating in a paroxysm followed by an interval of inactivity lasting from two to seven years, with three and one-half years as an average.

Perret, writing in 1922, states that the great 1906 basin of Vesuvius was then filled to within a short distance of the lowest portion of the rim, giving an accessible crater-bottom similar to that of Kilauea, but with a different kind of activity of far greater degree. He remarks that the future behavior of this volcano is a matter of the most intense interest.

The nature of a volcanic eruption, whether "explosive" or "effusive" is assumed generally to be based upon the mere difference of fusibility of the rock emitted. For instance, the eruption of trachytic and andesitic magmas oftentimes produces steep cones of fragmental deposits resulting from paroxysmal outbursts, while the readily fusible basaltic or more basic type gives rise to low, broad cones developed by liquid lavas. Perret suggests that this distinction can be maintained only with great reserve, since the steep volcanic cones are oftentimes built up of lava outpourings as well as of fragmental deposits, while in the basaltic type violent explosive phenomena not uncommonly accompany the molten flows. In fact, each type of magma may show both classes of phenomena. Perret considers that there are other clearly indicated conditions which control the nature of the manifestations, and determine the mode of action during the various phases of an eruption. An important factor is whether the conduit has been normally open or closed during the period preceding the eruption. If closed, the magmatic reservoir will generate and accumulate gas in the liquid material within and beneath the volcanic edifice. When gas, the chief eruptive element, has accumulated in the uppermost magma in sufficient quantity to pierce the crater plug, the prompt release and ejection of all or a part of this matter will constitute eruption.

Perret considers the magma a paste, which permits the transfusion of gas and which changes into liquid lava in the upper part of the column. It rises slowly, and when it reaches the zone of fractured rocks, considered to be some six miles thick, it will be exposed to water and air. The assimilation of these modifying elements has a profound effect upon the physical and chemical activities and upon the prolonged existence and repeated functioning of the volcanic vent.

Perret states that the subdivision of the magma, when it is more or less forcibly ejected, will depend upon the nature of the material, its physical condition at the moment of emission, and especially its gas-content. Since such material cannot flow in a coherent stream, it will be shot upward by the powerful gaseous expansion as finely divided ejecta. When material from lower levels in the conduit comes to the surface, it may take the form of "bread-crust" bombs, exploding magma-masses forming *nuée ardentes* or gas-free matter extruded as domes, spines, or viscous flows. Closed conditions of the lava conduit preceded the famous eruptions of Vesuvius in 79 and 1631, and the Mont Pelée and Soufrière outbursts in 1902.

When the conduit is open and free, the magma shows a different condition, especially in the upper portion of the column. Perret states that the upstreaming of gas with heat-carrying properties induces a powerful churning and stirring effect, and in spite of exposure to radiation, conduc-

tion, and loss of heat, it maintains the magma at a high temperature. So nearly perfect is the state of equilibrium between gas tension at the magma surface, and the weight of the atmosphere, that any variation of the latter reacts upon the rate of gas evolution with noticeable increase or diminution of the volcano's activity. This is especially noticeable at Stromboli.

At lower levels, a condition exists which is almost equivalent to a closed conduit. Due to the pressure of superincumbent material, the gas is retained and accumulates, forming a potentially explosive magma. Under such conditions successive zones of potentially explosive magma may arise in the magmatic column. When the gas accumulation has reached the point of saturation, all that is required to cause a great eruption is the intervention of some factor that is capable of disturbing the existing state of equilibrium.

This may be brought about by fracture of the wall of the conduit, resulting in lateral outflow and drainage sufficiently rapid and copious to materially reduce the liquid in the tube. The pressure on subjacent zones thus being relieved, a progressive process of expansion, rise, and expulsion will continue until the paroxysmal liberation of gas from the surcharged lower layers culminates in the outbreak, and exhausts the accumulation of energy and material. Then follows the cyclical interval of repose and renewal.

So mightiest powers by deepest calms are fed,
And sleep, how oft, in things that gentlest be!
—Barry Cornwall.

Photograph by F. A. Perret

LAVA ENTERING THE SEA

When the material is sufficiently hot, a protecting skin is formed upon coming into contact with water or snow. The molten lava will then flow along the sea bottom without any disturbance at the surface other than the steam clouds of the first contact. Scene along the Japanese coast during the eruption of Sakurajima, 1914

Panoram of Mounts Kukenam and Roraima photographed from a distance of about six miles

THE "LOST WORLD" OF MOUNT RORAIMA

The Account of an Expedition to a Strange and Little Known Flat-topped Mountain in the Heart of the South American Jungle

By G. H. H. TATE
Department of Mammals, American Museum

Photographs by G. H. H. Tate and T. D. Carter

TWENTY square miles of rough and rocky plain, carved by centuries of rainfall into a maze of gullies and rifts, masked by almost constant fog and mist—a bleak, forbidding island, in the far interior of the South American wilds, cut off from the world not by water, but by sheer precipices of red rock twelve hundred feet high that ring it round on every side. This is Roraima, the "Lost World" that Conan Doyle's vivid imagination filled with teeming broods of dinosaurs and pterodactyls.

This, too, is the "Father of Streams," whose vast bulk and personality dominate and shape the thoughts and lives of every Arecuna Indian for fifty miles around. Roraima—old and grim when Manhattan was yet buried deep beneath the glaciers of the last Ice Age—older and perhaps a little grimmer now, frowning down upon the surrounding South American wilderness with a cold inscrutability that has been a lure to the scientist and explorer ever since its discovery by Schomburgk in 1841.

The ledge leading to the top of the mountain is, for most of its length, broader than Fifth Avenue, New York; but it is a Fifth Avenue tilted on its side—inclined so steeply that cars and omnibuses would turn turtle and roll over the edge of the precipice. Besides having this rather inconvenient slope, the path is studded with rocks and buttresses and charred remains of forest.

The top of Roraima is, roughly speaking, level, although when we started to explore it, we found the entire surface carved and fretted into gullies, rifts, and castellated cliffs, balanced rocks and mushrooms on pedicels, and tables set on thick stone legs.

It was on October 21, 1927, that we pitched our camp at the base of Mount Roraima, after penetrating to the foot of its tremendous precipices in the interests of the American Museum of Natural History. Our expedition, which consisted of Mr. T. D. Carter, my brother Geoff, and myself, had been made possible through the generosity of Mr. Lee Garnett Day, who contributed the "sinews" for our assault upon this huge natural stronghold. Furthermore, we had been greatly assisted by the "free entry" accorded us by the Brazilian officials at Pará and by our pleasant association, later on our journey into the interior, with General Candido Mariano Rondon and his staff of officers, with whom we traveled to the base of the mountain that was our goal.

For three weeks we camped at the foot of Roraima, watching the clouds as they

"CAI EN AGUA"
All hands overboard to force the boat past a difficult rock

MEANS OF TRAVEL ON THE RIO NEGRO
The boat in the center supplies the motive power for all three. At short intervals stops are necessary in order to obtain wood from the wood piles that are kept stocked by natives ashore. The objects hanging from the lines are not laundry, but strips of beef drying in the sun

swirled about its summit—studying, collecting, observing with all our energy. Then, on the 16th of November, we made our way up the bowlder-strewn incline that is the only route to the top, and after a strenuous day, pitched our little camp among the strangely shaped rocks of that extraordinary place.

The cold light of our first daybreak on the summit of Mount Roraima filtered through the thin material of the tent and awakened me. At moments through the night I had been conscious of gusts of wind and rain tearing and lashing at our little shelter; but now the wind was still, the rain had ceased. Lying quietly on my cot, I reached up with one hand and pressed against a heavy sag in the canvas just above my head. The water rushed from the tiny lake to the ground.

I shouted to awaken my companions. Unintelligible grunts came from two heaps of blankets on neighboring cots, and the pup, Sunny, emerged from beneath my bed, yawned prodigiously, and stretched his limbs front and hind.

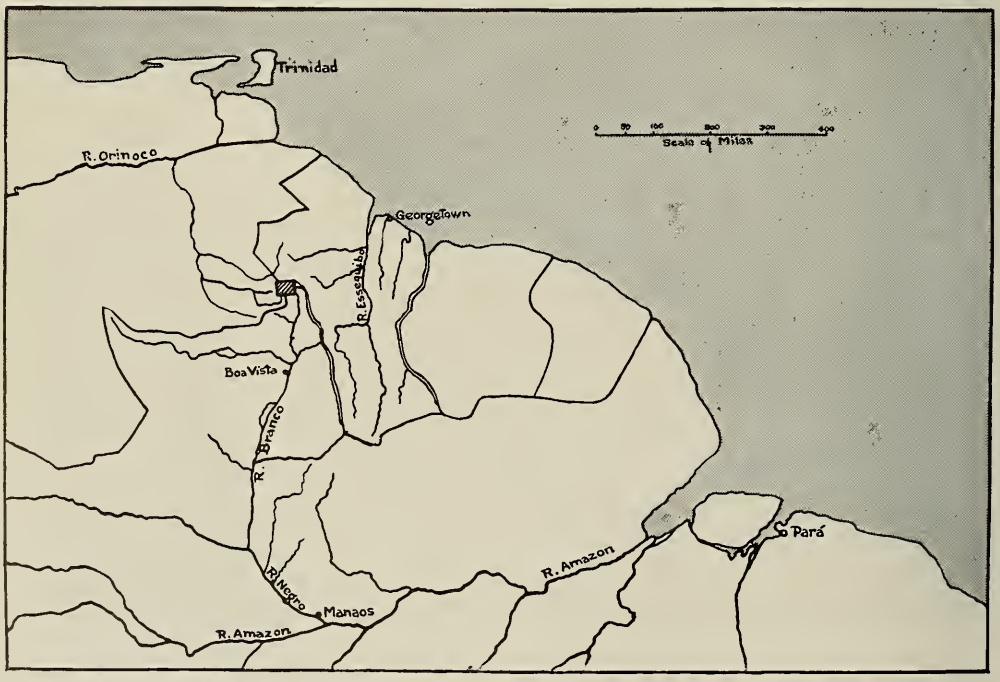
I struggled uncomfortably into clothes that were chill and clammy, fastened back the door flaps, put my head out, and shouted in the general direction of the kitchen tent.

"Adolfo! Are my shoes dry?"

"Sim, senhor."

Adolfo's answer was always in the affirmative, no matter what question I asked. Picking his way over the soggy ground, he brought me a pair of slightly warm, but still saturated objects that were once basket-ball shoes.

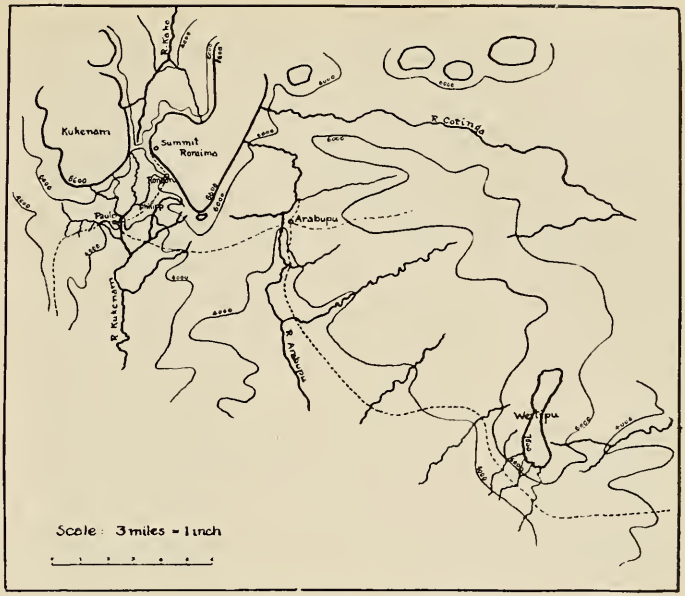
The mercury stood at fifty-one degrees; my two aneroids registered an average of 8600 feet above the level of the sea. The mist, eddying and billowing among grotesque rock masses all about, brightened to pearly white as the rising sun



THE SQUARE MARKS RORAIMA AND THE AREA WHERE THE EXPEDITION WORKED
The expedition journeyed up the Amazon to Manaos, and thence up the Rio Negro and the Rio Branco. Returning, the men traveled down the Rio Essequibo to Georgetown, British Guiana

gathered strength. Sounds of activity came from the tent behind me; so, shivering, I crossed by improvised stepping stones over a few feet of boggy ground to the large notch in the sandstone where we had our kitchen and work tents.

This spot, by the way, is the identical one where Mr. and Mrs. Clementi spent their one night on Roraima thirteen years ago. A little brass plate bearing their initials and the date is still firmly cemented in the rock.



THE VICINITY OF RORAIMA
Showing the five camp sites of the expedition. These represent altitudes between 4000 feet and the summit, 8600 feet

As I stooped at the edge of the cook-house tarpaulin, a cloud of acrid wood smoke blew full in my face, and I realized that José, our combined cook and animal trapper, had emerged from his nocturnal torpor, and was preparing oatmeal and coffee.

"Bom dia, senhor."

"Good morning, José. Be quick with that breakfast."

I passed on to the second shelter, which served both as laboratory and dining room. Its floor had been raised above the mire by roughly paving it with rocks, and although the stonework kept our feet dry, it was difficult to place a camp chair so that it rested on more than three legs. I finished entering my weather records just as Don and Geoff came in, and a few minutes later we sat down to breakfast.

The meal over, I whistled to Sunny and started out to explore the rocky basin at the edge of which we had pitched our camp. The fresh herbage with the glint of raindrops on it was entrancing, and the many new (to me) varieties of plants delighted me. Yet, too, what a bleak, remote aspect had this place where no man had set foot for more than half a score of years.

I strolled slowly, picking my way among age-old rocks separated from one another by ruts and trenches filled by swamp herbage. Here were spiky-leaved *Xyris*, mats of pitcher plants, pipeworts, and sundews. Farther along was a hollow where the water stood knee-deep nearly covering great masses of sphagnum moss. The chief plant of these depressions, though, was *Bonnetia*, a stunted, gnarled little tree with small reddish-green leaves and a sprinkle of white flowers. Its base was hidden deep beneath the sopping sphagnum. The only firewood on Roraima is furnished by *Bonnetia*. According to Quelch, a previous visitor, the *Bonnetia* sometimes reaches a height of thirty-five feet. I fear he must have chopped that one down. Fifteen feet is about the limit.

I stood and watched Sunny. Breast-

FORDING THE MIANG RIVER
The Indians who served as porters for this portion of the journey were of the Macuxi tribe

deep in a pool and nearly motionless except for his tail, he was gravely intent upon his efforts to tread on the plump but agile dragon fly nymphs abundant in every pond.

Near by, at the foot of some cliffs where grew a fair profusion of vegetation, were a few little runways and signs that at least some sort of small animals were at home on the summit. At rare intervals, too, birds hopped and chirped, it seemed to me rather disconsolately, in the branches of the *Bonnetias* and bushes among the rocks. The only common kind was McConnell's song-sparrow.

The sun shone out as I crossed a level stretch of sandy swamp dotted with sedges and sundews, and I saw Sunny racing toward me apparently pursuing a butterfly. It was soon plain that he had mistaken the shadow for the substance, for he was much puzzled when the insect, a black *Satyrid*, floated over an eight-foot rock and its shadow suddenly vanished.

In camp I found Don, who had also been "sizing up" things. He had seen a pair of the rare *Diglossa* honey creepers. While he was watching them hop about among the bushes, they suddenly disappeared. He was not greatly perturbed at neglecting to shoot them, for he concluded that he could easily obtain others.

AN ARECUNA INDIAN
Hanging to the pole is a prehensile-tailed anteater which this native brought alive to the expedition's camp at the foot of Roraima

AFTER LUNCH AT THE CAMP OF GENERAL RONDON

General Candido Mariano Rondon, while making a border survey for his government, visited Roraima, and the American Museum expedition was fortunate in being able to travel with him

As a matter of fact, though we caught glimpses of one not infrequently, he collected only one on the last day of our stay on the plateau. Their real home is in the forests at the base of the cliffs, where we caught many.

Don and Geoff had explored to the east of the camp, and had worked their way among great rocks and bowlders and among bog-filled crevices to the crest of a low range of sandstone hills. Their objective had been a point which we named the "Tiger's Ear," and which served subsequently as one of the chief landmarks for our compass survey.

Assisting each other, they had managed to climb up the "Ear" and tie there a slender pole to which was fastened a flag made of handkerchiefs.

I set José and Adolfo promptly to work baiting traps, as I wished to set as long a line as we possibly could before nightfall. We used the common guillotine rat traps in two sizes. For bait we carried with us a composite mixture of rolled oats, bacon, raisins, and peanut butter—all ground up quite finely and intimately mixed together. Such sumptuous fare was a temptation that a "coun-

MR. TATE (LEFT), THE LEADER OF THE EXPEDITION

With his brother and the party's mascot on board the scow in which, with the aid of two outboard motors, they navigated the Rio Branco. One of the motors had a habit of catching fire

A VIEW FROM THE TOP OF RORAIMA

The mist almost constantly welled up the perpendicular cliffs and kept the party shivering and depressed. Sunshine was rare and photography was exceedingly difficult

A VIEW FROM THE CAMP AT THE BASE OF RORAIMA

Philipp Camp, from which this picture was taken, was only two miles from the base of the cliffs, whose crests towered 3400 feet above the tent shown in the foreground

CAMP ON THE SUMMIT OF THE MOUNTAIN

The low places between the rocks were soft and miry; except for these boggy spots, the surface of the flat-topped mountain was rocky and exceedingly rough

THE "LABORATORY" AND "DINING ROOM"

Adolfo, whose specialty was trapping and skinning, is shown here with part of a day's catch. The laboratory served also as a dining room, and at mealtimes the bottled frogs and pickled centipedes were removed from the table and were replaced by beans, rice, and coffee

A FALCON FROM FRECHAL

(*Above.*) This little bird bears the scientific name *Cerchneis sparveria distincta,* but was much more handicapped by a slight wound in one wing

MR. CARTER WITH TWO SMALL CAPTIVES

(*Right.*) Some maneuvering was necessary before the two birds consented to pose. The owl was used as a decoy by his Indian owner

In the "Lost World" the silence seems to have a quality that produces a numbing, oppressive effect on the senses, so that setting traps out alone somewhere in that cold rain becomes anything but a pleasant occupation. Yet, a large number of our "out-of-sights" were lying in wait by little highways when night fell.

In the morning, when I looked at my traps, I felt well rewarded for the months spent in traveling to our goal, for there were several specimens of *Thomasomys mcconnelli,* the queer little mouse that has appropriated Roraima's summit and slopes for its homeland. In one of the last traps, set deep amidst reeking cushions of sphagnum moss and a tangle of low-growing bushes, lay a different creature try mouse" could seldom resist. Indeed, I felt sometimes, to judge from its rate of consumption, that perhaps José felt it sinful to waste such a repast on mere rodents. This follower of ours hailed from Iquitos in Peru, and a meeker, milder soul I have seldom encountered. Yet he was a prudent individual. It cut him to the heart to see anything thrown away. We had to use stealth to get rid of even a used tomato can, for he invariably retrieved every object he could find. Some months later, when we left Roraima, José staggered under a load of salvage that would have daunted even one of our Indian porters.

A BELL BIRD (*PROCNIAS VARIEGATUS*) OF THE RORAIMA FOREST

(*Below.*) Its ringing notes seem almost to originate at some blacksmith's anvil. The wattles of the handsome creature look very much like a beard

—a little, shrewlike animal with a long, pointed snout.

"*Cœnolestes*," I exclaimed aloud, although I was quite alone. *Cœnolestes* is a strange "living fossil" marsupial of the high Andes, and its occurrence on Roraima would have been of the highest interest. The new animal, as it lay dead in the trap, looked the very picture of one. Its teeth, however, proclaimed it a rodent. Tiny eyes, no bigger than a pin's head, suggested that sight might not rank very highly among its senses. Hearing, smell, and taste, on the other hand, were without doubt acute. And what a coat! Beautiful, soft, lax fur that brushed in any direction—fur so long in proportion to the creature's size that even a prize Persian cat might be filled with envy. Back at the "lab" I exhibited it gleefully.

BELL BIRD AND OWL (*Above.*) The larger of the two seems somewhat perturbed by the presence of the other

A SOUTH AMERICAN OPOSSUM (*Left.*) This creature is allied to our Virginian species, but has a longer tail. Captured in dense forest near Arabupu

A TINY OWL OF THE GENUS *GLAUCIDIUM* (*Below.*) This bird was a pet of one of the Indians of the party. Its size is better shown in the picture at the top of this page

As the days passed, we learned the best routes for crossing rapidly to the center of the plateau. Where before we had spent hours clambering through intricate labyrinths of sculptured sandstone, jumping across great cracks that every few minutes appeared before us, or feeling our way over rather treacherous bogs in the deeper hollows, now we could take the easiest paths well afield, and thence strike out still farther. Moreover, we now knew our way well enough to be independent of the mist. In that way we reached the southern point of the mountain and Gun Rock at the southeast of the Great North Bay.

In the evenings, when the fog closed

down and the pelting rain increased, we returned to camp. And José and Adolfo, having finished the day's skinning of birds and animals, would be crouching quietly over the fire in the gathering darkness, engaged in preparing beans and rice for supper. One of us would pump up the reservoir of our gasoline lantern. Then, with the light shining on the dank rock walls at either end of our tarpaulin, we would sit down to our appetizing food.

An important part of the table setting was my cyanide killing-jar, with which I rose at intervals during the meal and captured unwary night-moths and errant daddy long-legs that paused on the canvas ceiling.

KAIETEUR FALLS
The Falls, more than four times as high as Niagara, can rarely be photographed because of the mists enveloping them

Meanwhile José and Adolfo would profit by the light to spread their blankets on a thick couch of *Bonnetia* twigs and leaves, and would complete their last duty of the day — the preparation of cups of steaming-hot cocoa, which we drank just before retiring.

Such days were typical of the twenty-one we spent on Mount Roraima. Soaked by rain and mist, balked in our photography by the clouds that seemed constantly to hang over our rocky surroundings, we nevertheless were able to collect more than 200 species of birds, mammals, invertebrates, and plants. As yet we cannot tell how many of these have never before been described, but we feel confident that the number will be considerable and that our journey to the "Lost World" of Roraima will have proved worth while.

NOTES

ASTRONOMY

At the first annual meeting of the Amateur Astronomers Association, held May 17, the following officers were elected: President, G. Clyde Fisher; Vice Presidents, Stansbury Hagar; George A. Galliver; Dr. Oswald Schlockow; C. W. Elmer; Secretary, M. Louise Rieker; Treasurer, Charles J. Liebman.

In coöperation with the Nature Trail of the American Museum at Bear Mountain, Palisades Interstate Park, the summer activities of the Association will include a series of Saturday evening meetings at 8 P.M on the lawn at Bear Mountain Inn. The speakers as scheduled are:

June	2	Mr. Stansbury Hagar, "American Indian Legends of the Celestial Bear and Mummy."
"	9	Dr. Clyde Fisher, "The Discoveries of Galileo."
"	16	Mr. Charles J. Liebman, Jr., "Saturn and His Rings."
"	23	Mr. G. H. Lutz, "Telescope Making."
"	30	Mr. H. D. Benner, "Know Your Stars."
July	7	Dr. Oswald Schlockow, "Daily and Annual Movements of Stars and Planets."
"	14	Mr. Frank Reh, "A Journey Through Space."
"	21	Dr. Clement S. Brainin, "The Changing Stars."
"	28	Mr. S. L. Toplitz, "Locating Direction by Constellation other than the North Star Group, Ursa Minor."
Aug.	4	Mr. Cornelius Wolff, "The North Circumpolar Constellations."
"	11	Mr. Paul Shogren, "Phases of the Moon."
"	18	Mr. C. W. Elmer, "The Meridian Constellations."
"	25	Mr. William Henry, "Sun Spots."
Sept.	1	Mr. Max Lipkind, "Shooting Stars."

Summer activities will also include meetings at the North Star Altar, on the grounds of the American Museum, 77th Street and Central Park West, New York, on Tuesday and Thursday evenings, under the direction of Mr. H. D. Benner and his associates.

EDUCATION

In accordance with the policy of the Museum's department of education, to give the pupil teachers of the Training Schools an opportunity to become acquainted with the facilities which the Museum offers to teachers, receptions were held for the faculties and graduating classes of the New York Training School and the Maxwell Training School on June 11 and 14 respectively.

The Association of Teachers of Blind and Sight Conservation Classes, also were entertained on June 5.

There were illustrated talks in the auditorium, followed by a short tour of the Museum and the School Service Building. The groups reassembled at four o'clock in the North Bird Hall for afternoon tea and a little social gathering.

Museum Courses at Columbia.—Realizing the need of systematic training for Museum workers, Columbia University is offering two summer courses in Museum training on its curriculum. The aim is to give both a theoretical and a practical knowledge of the principles upon which new museums are established, old ones reorganized, and progressively better methods worked out for all. These courses are designed for directors in museums outside the great museum centers, for assistants needing a general view of museum administration, for curators of art galleries, custodians of historical museums, and for the young college graduate who has specialized in art, anthropology, science, or the history of civilization.

EXPEDITIONS

The American Museum Tanganyika Expedition.—The Museum's collections of African birds are to be increased by the results of an expedition now being planned by Messrs. J. Sterling Rockefeller and C. B. G. Murphy, of Yale University. Leaving New York at the end of June for a short hunting trip in Tanganyika Territory, Messrs. Rockefeller and Murphy will be accompanied by Mr. Allan L. Moses, the well-known bird-collector of Grand Manan, who has already worked in West Africa as a member of the Cleveland Museum Blossom Expedition. After a visit to the famous big-game country of East Africa, the entire party will devote its attention to the avifauna, proceeding to Lake Tanganyika and the adjacent highlands of the Belgian Congo. Thus, besides adding to the representation of birds from eastern Africa, the expedition aims to complete the ornithological survey of the Belgian Congo, which the American Museum, in coöperation with the Musée du Congo Belge, has been carrying on since 1909.

The Scientific Work of Commander Richard E. Byrd's Forthcoming Expedition to the Antarctic is to be under the auspices of the American Museum. A special room has been set aside in the School Service Building as scientific headquarters of the expedition, and experts of the Museum staff will assist Commander Byrd and his staff in outlining a program of scientific activities.

Prof. Henry Fairfield Osborn gave a luncheon at the American Museum June 4, in honor of Commander Byrd. The most recent Antarctic maps of the region Commader Byrd will explore, and literature on recent Antarctic exploration compiled by Scott, Mawson, Amundsen, Shackleton, and Charcot, as well as the final publications of the British Antarctic Expedition of 1910–13,

the National Antarctic Expedition of 1901–04, and the French Antarctic Expeditions of 1903–05 and 1908–10 were on display at the luncheon, and will be exhibited beside the model of the south polar regions, which has been installed in the Memorial Hall of the Museum. Among the guests at President Osborn's luncheon were Commander Fitzhugh Green of the Crockerland Expedition, who reached the scene of the supposed Crockerland; Dr. Robert C. Murphy, who directed two expeditions to the Antarctic; Dr. Chester A. Reeds, head of the department of geology; George Palmer Putnam; Director George H. Sherwood; Dr. Charles H. Townsend; Earl Dodge Osborn; and Wayne M. Faunce.

The Central Asiatic Expedition cables that it has reached the Shara Murun Beds, 350 miles from Kalgan. Also that Dr. Roy Chapman Andrews had been accidentally shot in the leg, but that fortunately the injury was not permanent, and Doctor Andrews is recovering satisfactorily. He has therefore remained with the expedition, which will leave shortly for the Gobi Desert. The leaders are optimistic about the work for this season.

The *Birmingham Post* of April 17, 1928, in commenting on the departure from Kalgan of the Central Asiatic Expedition, says:

"First catch your brigand, then take him," seems to be the motto of the scientists exploring the Central Asian plateau. Today, Mr. Roy Chapman Andrews of the American Museum of Natural History left Kalgan at the head of the Central Asiatic Expedition after having made full forward arrangements with brigands who infest Mongolia, that the work of the expedition should proceed without hindrance.

This is the fourth expedition Mr. Andrews has led into Mongolia. On the last occasion he brought back the famous dinosaur eggs. . . . Following a very interesting discovery near Peking, he and his fellow scientists are out to look for human remains older than the Java Ape Man discovered last century by Dr. Dubois. The interesting discovery referred to was made last summer by Dr. Davidson Black, of the Peking Union Medical College, in the Western Hills twelve miles from Peking. It was an ancient human tooth as old as the Java Ape Man and possibly older, according to Mr. Andrews, and has been named Sinanthropus, or the Peking Man.

"This," said Mr. Andrews, is probably the oldest and most important piece of human remains yet discovered. It is at least a million years old, and possibly older. Its discovery has been an enormous stimulus to the expedition, and shows we are on the right track. . . .We are going to search strata and deposits of the oligocene age which, a few years ago, would have been thought far too old to contain human remains.

The expedition left Kalgan in eight three-quarter ton motor-lorries, and consists of ten foreigners and 26 Mongols and Chinese. The caravan consists of 125 camels, carrying petrol, scientific equipment, and food for six months for 36 men.

The Stoll-McCracken Siberian Arctic Expedition has on two occasions been in touch with radio receiving stations in the United States. One message, received May 15, stated that the "Morrissey" was heading across the Gulf of Alaska for Isanotski Straits and Port Moller, and that all were well aboard.

On May 22 the schooner had entered Bering Sea through Unimak Pass after a delay of two days behind Unimak Island, due to storms. Here Father Demetrie Hotowiski, the famous Alaskan Russian priest and big-game hunter, joined the expedition.

FOSSIL VERTEBRATES

Dr. W. D. Matthew, professor of palæontology at the University of California, is making a two months' visit to the American Museum in order to continue his studies of its Paleocene collections. Doctor Matthew began these studies while curator of vertebrate palæontology at the Museum.

INSECTS

The department of insect life has been greatly strengthened by the appointment of Mr. C. H. Curran as assistant curator in charge of Diptera. This group of insects, which includes flies and mosquitoes, contains more than twice as many species as there are of all vertebrate animals, including birds and fishes. Consequently there is a great need for curators in this field.

Reconstruction work, made necessary by the doming of the Mammal Hall, has started in the Insect Hall. Eight habitat groups are being reinstalled and provision is being made for twenty-four more. At the same time a long-desired change in lighting is being carried out. According to the new plan each case throughout the hall will be individually illuminated from within the case, making it much easier to see the small specimens on exhibition. It is hoped that the hall may be in presentable shape when the meeting of the International Congress of Entomology is held in August.

Prospects are bright for a very successful season at the Museum's Station for the Study of Insects in the Harriman State Park near Tuxedo, New York. Since all of the Nature Trail activities have been transferred to Bear Mountain, more emphasis will be laid this summer on the primary purpose of the Station, which will continue to be under the direction of Curator Lutz.

MAMMALS

South Asiatic Mammal Groups.—On April 23 last, there was placed on public exhibition at the American Museum, a series of groups of South Asiatic mammals which have been collected by Arthur S. Vernay and Col. J. C. Faunthorpe during the last five years. These groups form the nucleus for the exhibits that are to be installed in the new hall to be devoted to the large game animals of India, and are the gift of Arthur S. Vernay.

The admirably realistic results obtained are

due in many respects to the ability and inventive genius of Carl Akeley, who, as far back as twenty-five years ago, devised the taxidermy methods in use at the Museum at the present time.

The work of the Indian Hall is being carried on under the able direction of Assistant Director James L. Clark in charge of preparation, in collaboration with R. H. Rockwell, Louis Jonas, and John Hope, taxidermists of the Museum staff.

Mr. George G. Goodwin is about to start field work in Connecticut, preparatory to the writing of a report on the mammals of that State. The work is supported jointly by the American Museum of Natural History and the Connecticut Geological and Natural History Survey.

HONORS

Prof. Henry Fairfield Osborn was awarded the degree of Doctor of Laws by Union College, Schenectady, on June 11, in recognition of the active part he has taken in exploration and in the discovery of remains of extinct animal life, and in the interpretation of these discoveries, which has resulted in important advances in the science.

Director Sherwood Honored.—On June 18, Brown University conferred upon Director George H. Sherwood of the American Museum, the degree of Doctor of Education in recognition of the work accomplished by him in the educational field, especially in connection with the Museum and the schools of New York City.

Lincoln Ellsworth, a trustee of the American Museum, who with Roald Amundsen made the now historic Polar Flight of 1925 and the Transpolar Flight of 1926, has been awarded a gold medal by an Act of the Seventieth Congress of the United States of America, in recognition of his courage, sagacity, and perseverance. By the same Act, President Coolidge was authorized to receive from Mr. Ellsworth in the name of the nation, the flag which he took from King's Bay over the North Pole to Alaska. This flag is at present on exhibition in the American Museum. A reproduction of the original Act is shown on this page.

The story of these two polar flights appeared in Natural History for May–June, 1927.

Dr. E. E. Lowe, director of the Leicester City Museum Libraries, in a report recently published in *The Museums Journal*, speaks in a highly complimentary manner of the American Museums which he toured last year. The American Museum is pleased to note that he commented upon the coöperation of the museums of this country with the school children, and singled out for special praise the American Museum for its prospective activities in natural history education.

S. 3919

Seventieth Congress of the United States of America;

At the First Session,

Begun and held at the City of Washington on Monday, the fifth day of December, one thousand nine hundred and twenty-seven.

AN ACT

Awarding a gold medal to Lincoln Ellsworth.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the President of the United States is hereby authorized to present a gold medal to Lincoln Ellsworth, the distinguished American explorer, who, by his conspicuous courage, sagacity, and perseverance made his famous polar flight of 1925, and the transpolar flight of 1926, and the President is further authorized to present gold medals of honor to Roald Amundsen, the distinguished Norwegian explorer, and to Umberto Nobile, the distinguished Italian explorer, who participated with the said Lincoln Ellsworth in the transpolar flight of 1926.

Sec. 2. That the President of the United States is hereby authorized to receive, in the name of the Nation, the American flag which the said Lincoln Ellsworth took over the top from Kings Bay over the North Pole to Point Barrow and Teller, Alaska.

Speaker of the House of Representatives.

Vice President of the United States and President of the Senate.

CONSERVATION

Destruction of the Cumberland Falls.—Although they have been but little visited by tourists, the Cumberland Falls, on the Cumberland River below Williamsburg in southeastern Kentucky, are, after Niagara Falls, the finest and greatest in the eastern half of the United States.

As the Cumberland River is in part a navigable one, the control of these falls comes under the Federal Power Commission, with which the Cumberland Hydro-Electric Power company has filed an application to construct a dam and power development that will ruin the falls from a scenic standpoint, in spite of claims to the contrary by the electric company. Numerous other sites for power development exist in that region and the destruction of one of the grandest scenic places in the eastern states is needless.

An offer to purchase 2200 acres of land, including and surrounding the falls, and give it to the state for a park, has been made by Senator Coleman Du Pont. He has also offered to reimburse the electric company for all expenses (for surveys, investigations, etc.), thus far incurred, but the company has exercised its option and purchased 200 acres at the falls to which its claim entitled it.

Nothing now stands in the way of the immediate destruction of the falls except the Federal Power Commission, which will doubtless soon give its consent to the application unless public opinion makes itself heard without delay.

The Cumberland Falls Preservation Association, 319 East Main Street, Corbin, Kentucky, is making an effort to have the falls preserved and made a state park, and will be glad to furnish information or receive help. Letters of protest against the destruction of the Cumberland Falls should be sent to the Federal Power Commission, Washington, D. C. or to the Secretaries of Agriculture, War, or the Interior, who are members of it.

To Save the Antelope.—As a culmination of the efforts of wild life conservationists extending over a period of several years, a definite step has just been taken to perserve the remnant of the prong-horned antelope of the Nevada-Oregon region. Some time ago at a national conference called in Washington to consider means of saving these beautiful animals in the semi-desert regions of the West, the National Association of Audubon Societies was appointed to take the lead in securing by congressional action the establishment of an antelope and sage hen reservation in southeastern Oregon. Political interference at the behest of the nomadic sheep herding interests caused the project to fail. Since that time the state of Oregon has declared the killing of antelope in this region to be illegal, but as no wardens are available to enforce the regulation, conditions so far as the antelope are concerned remain virtually unchanged. Reports are current that wandering sheep herders and other travelers of the deserts continue to destroy the small bands of antelope that still remain. Across the line in Nevada an analogous situation exists, but it is here that a real reservation has at last been created.

While Dr. T. Gilbert Pearson, president of the Audubon Association, was engaged in field work in the west last summer, he learned from E. R. Sans of Reno, of the peculiar conditions that surround the Last Chance Ranch in northern Nevada. This range of 880 acres owned by the Hapgood Brothers contains open water, and water in this desert means many things, one of which is that from great distances antelopes come in spring to drop their fawns on the slopes surrounding the water hole.

"We have taken over the Last Chance Ranch of the Hapgood Brothers for an antelope sanctuary," said Doctor Pearson "and it is hoped that for all time we will thus be able to preserve much of the herd of antelope that still remains northern Nevada.

"While the National Association of Audubon Societies has for many years been working with others to preserve the remnant of big game in the west, all the reservations and sanctuaries we have thus far acquired have been for the preservation of ducks, geese, and other forms of bird life."

Doctor Pearson gave much praise to Mr. Sans of Reno, whose deep interest in the saving of these rare animals, he said, made possible the acquisition of this territory.—R. T. Hatt.

MARINE LIFE

American Sperm Whaling.—Two more of the eight cartoons of the Benson murals, illustrating whaling along the New England coast, have been received, and Mr. A. A. Jansson of the Museum's department of preparation is busily engaged in painting the large canvases from the originals. Dr. R. C. Murphy is supervising the technical details of these murals, which are to occupy the lunettes in the new Hall of Ocean Life.

The department of lower invertebrates regrets to announce the death of Mr. Robert H. Hazard, on April 7, at the age of seventy-four. Mr. Hazard was first connected with the American Museum in 1908, and was well known to all visitors to the Darwin Hall of Biology, where his duties were those of departmental docent. He was a gentleman of considerable culture and had an excellent command of language. His tact in approaching visitors and the lucidity with which he explained the exhibits in the Darwin Hall were great factors in increasing their educational value. Mr. Hazard had been seriously ill for more than a year. He will be greatly missed, not only by his friends, but by the visitors to the Darwin Hall.

The New Rotifer Group in the Darwin Hall has been completed, and will be placed on exhibi-

tion in September, when the general redecoration and remodeling of the hall is finished. The group shows the microscopic life contained within one-half an inch of pond bottom, magnified 100 diameters, or, cubically, 1,000,000 times. The remarkable complexity of life within so small an area is well illustrated in this group, which in itself is an unusual demonstration of skill in glass modeling on the part of Mr. Herman Mueller, of the departmental technical staff. A more detailed account of the group will be presented in a later number of NATURAL HISTORY.

MINERALS

CURATOR HERBERT P. WHITLOCK has been recently elected president of the New York Mineralogical Club to succeed Prof. Paul F. Kerr.

Curator Whitlock also was selected to represent the New York State Museum at the inauguration of Dr. Frederick B. Robinson as fifth President of the College of the City of New York.

REPTILES AND AMPHIBIANS

EXPERIMENTAL BIOLOGY IN THE AMERICAN MUSEUM.—Naturalists for centuries have been recording the *course* of evolution and have speculated as to its *causes*. Experimental biology has shown us that the gene is the physical basis of heredity, but it has not shown us how the gene does its work or exactly what the relation of the invisible gene to the visible character might be. The hereditary process may be likened to a complicated machine. We know what materials go into it and what products come out, but by what stages these materials are changed into the final product still remains a great problem for investigation.

For some time Doctor Noble of the Museum staff has been making an experimental study of species characters. His papers include investigations on the causes of retarded development in the permanently aquatic salamanders, usually called perennibranchs; the factors controlling the form of the teeth in certain salamanders; and the changes in the structure of the heart correlated with cutaneous respiration. In a paper recently published in the *Journal of Morphology and Physiology* Doctor Noble and Miss Jaeckle have worked out the evolution of the tree-climbing apparatus of the tree frogs, and have found that this highly adaptive mechanism arose in phylogeny before the frogs became arboreal; further, it was retained in other species which have taken up again the terrestrial habit. In brief, Doctor Noble and his associates have been analyzing the origin of adaptations and the determiners of species characters. They have in progress extensive experimental studies on the causes of blindness in the blind salamanders, the factors controlling tooth form in vertebrates, and the factors which determine the color pattern of animals.

The Trustees of the American Museum in recognition of these important contributions to general biology have recently changed the name of the department of which Doctor Noble is curator, to "The Department of Herpetology and Experimental Biology." Further plans are well in hand to make experimental biological investigation one of the major research activities of the Museum.

SALAMANDERING IN THE GREAT SMOKIES.—Mr. William G. Hassler has recently returned from the Gatlinburg area of the Great Smokies where he has been making extensive collections of salamanders which are to be used in experimental research.

SCIENCE OF MAN

THROUGH THE INTEREST AND PATRONAGE OF MR. MYRON I. GRANGER, of New York City, the American Museum is sending an ethnological expedition to Dutch Guiana under the leadership of Dr. Morton C. Kahn, the objective being to collect and study among the Bush Negro colonies in that country. Doctor Kahn visited some of the Bush Negro villages last season and brought to the Museum a very interesting collection. An account of these people appears on page 243 of this issue of NATURAL HISTORY.

THE MARCH-APRIL COVER DESIGN OF "NATURAL HISTORY"

An excellent example of the possibilities of using skin-color records made by the Bradley Color Top method in the study of racial types is shown in the color reproduction of an Australian head appearing on the cover of the March-April number of NATURAL HISTORY. Mr. A. A. Janssen, the artist, had as a guide, skin-color data recorded in this way by C. B. Davenport of Cold Spring Harbor on his recent visit to Australia.

MEETINGS OF SOCIETIES

THE INTERNATIONAL CONGRESS OF ENTOMOLOGY will hold its formal meetings at Ithaca, beginning August 12, but most of the foreign delegates, especially those from England, France, and Spain, will arrive in New York City on the "Tuscania" three days before leaving for Ithaca. Curator Lutz has been requested to arrange a program of scientific sight-seeing for these three days and then, meeting the delegates coming on a second boat, proceed with the united party to Ithaca. New York headquarters for the Congress will be in the East Tower room on the third floor of the American Museum.

A Considerable Attendance from Abroad is already assured for the Twenty-third Session of the International Congress of Americanists, who are to be the guests of the American Museum of Natural History during the week beginning September 17. Meetings will also be held at Columbia University, the Museum of the American Indian (Heye Foundation), and the Brooklyn Museum. There will be one general session and several sectional meetings.

The first of these Congresses was held in Nancy, France, in 1875, for the purpose of discussing the native races of America, their history, languages, habits, and customs. Frequent sessions were held in Europe until 1900 when, at a meeting in Paris, revision in the constitution provided for biennial sessions alternating between the Old and the New World. The Thirteenth Session also was held at the American Museum in October, 1902, when Morris K. Jesup, the president of the Museum, was president of the Congress.

Linnæan Society's Medal Goes to Dr. Merriam—The Linnæan Society's Medal, awarded to Dr. C. Hart Merriam for his eminent work in mammalogy, ornithology, and zoögeography, was presented to Doctor Merriam by Dr. Frank M. Chapman in Washington, D. C., on May 30. Doctor Merriam was one of the founders as well as the first president of the Linnæan Society of New York, which has recently celebrated its Fiftieth Anniversary; and the first two volumes of the *Transactions* of the Society are largely devoted to Doctor Merriam's historic report on the "Mammals of the Adirondack Region." His distinguished career as Chief of the United States Bureau of Biological Survey is universally known.

The previous recipients of the Linnæan Medal are Dr. Frank M. Chapman, Dr. D. G. Elliot, and Dr. J. A. Allen. The Linnæan Society was founded on March 7, 1878, by H. B. Bailey, F. Benner, E. P. Bicknell, John Burroughs, Harold Herrick, Dr. F. H. Hoadley, Ernest Ingersoll, N. T. Lawrence, Doctor Merriam, and William C. Osborn. For some years its meetings were usually held in the rooms of the American Geographial Society, 11 West Twenty-ninth Street, but since 1891 the Society has met in the American Museum. Following Doctor Merriam, the successive presidents of the Linnæan Society have been: E. P. Bicknell, G. B. Sennett, Dr. J. A. Allen, Dr. F. M. Chapman, Dr. J. Dwight, Walter Granger, J. T. Nichols, Dr. E. R. P. Janvrin, Ludlow Griscom, and J. P. Chapin.

From the outset the Linnæan Society's interests have been largely ornithological, although other branches of vertebrate zoölogy have not been overlooked. The Society has always exercised a most valuable influence in the training of young naturalists, and has been a favorite meeting place for them in later years as they pursued their studies and returned from their travels. There are indeed few areas of the world that have not been visited by trained observers from among the members of the Linnæan Society.

The Golden Anniversary of the Society was appropriately celebrated on March 13, 1928. At the Fiftieth Anniversary Dinner, held at the Manhattan Square Hotel, two of the founders, Messrs. Herrick and Ingersoll, were present, as well as two of the first members subsequently elected to the Society, Drs. G. B. Grinnell and A. K. Fisher. Doctor Merriam, Mr. Benner, and Mr. W. C. Osborn sent their regrets that they were unable to attend. The Anniversary Meeting, held afterward at the American Museum, was addressed by those of the founders, former presidents, and early members who were present. Their reminiscences were illustrated by many lantern-slides from photographs of officers and members who had taken an active part in the work of the Society, showing them often in field costume, or at work in distant corners of the world.

American Museum Building Plans

The Board of Estimate and Apportionment is continuing the building program of the American Museum, and on May 7 approved $150,000 for the preparation of plans and specifications of the African Hall (Section 13 of the Museum building) and the power and service section (Section 17). The estimated cost of these two buildings will be $2,000,000.

The African Hall is greatly needed for the exhibition of the superb African groups presented by George R. Eastman, Daniel E. Pomeroy, Daniel Wentz, Arthur S. Vernay, and others. The service and power section is required for the adequate heating and lighting of existing buildings, and the new sections of the Roosevelt Memorial. Messrs. Trowbridge and Livingston have been appointed architects for both these sections, and it is expected that the plans will be completed so that these buildings can be erected at the same time the Roosevelt Memorial Building is being built by New York State early in 1929.

The Fifty-Ninth Annual Report of the American Museum, entitled "Building the American Museum" was issued on May 1, 1928. In this report President Osborn gives the history of the building and future construction needs. Included in the report is the series of plans through

which the architects have finally developed the plan that is now being carried out. The first plan was prepared by Alfred S. Bickmore in 1863, after a conference with Sir Richard Owen, director of the British Museum, South Kensington. During the twelve following years, the plan was greatly elaborated and, from a single elongated series of halls, it was changed to an enormous square with four additional halls making a cross and meeting in its center. Basically the plan of 1875 is the one that is now being developed, although in the intervening years many changes and improvements have been incorporated into the plan.

ERRATUM

Unfortunately, the illustration on page 203 of the March–April NATURAL HISTORY, showing an Indian hunting party returning to its encampment, was wrongly credited to Carl Bodmer instead of to William De La M. Cary. The original painting, entitled "A Crow Hunting Camp," was one of a collection that Mr. Cary exhibited at the American Museum of Natural History in 1917. This collection was of much historic interest, as most of the scenes were painted between the years 1861 and 1875, and present faithful pictures of many phases of plains life before the coming of the railroad.

NATURAL HISTORY is glad to make this correction, and to give due credit to Mr. Cary, who so graphically painted these old-time scenes of Indian and pioneer American life.

NEW MEMBERS

SINCE the last issue of NATURAL HISTORY, the following persons have been elected members of the American Museum, making the total membership 10,500.

Associate Founder

Mr. EDWARD S. HARKNESS.

Honorary Fellow

Mr. WILLIAM J. MORDEN.

Honorary Life Members

Messrs. ROLLO HOWARD BECK, STEPHEN KLASSEN.

Patron

Mr. WILLIAM HALE HARKNESS.

Life Members

Mesdames DAVID C. HANRAHAN, KATHERINE POMEROY.

Miss MILDRED KAMSLER.

Captain DAVID C. HANRAHAN.

Messrs. FRANK L. CONNABLE, RAYMOND M. CURTIS, HARRY P. DAVISON, CLIFFORD HEMPHILL, ROLAND M. HOOKER, FRANKLIN J. HORNE, C. ALAN HUDSON, H. DAVIS IVES, AUGUSTUS HOWARD IVINS.

Sustaining Member

Mr. HANS WICKENHAUSER.

Annual Members

Mesdames JAMES BOYD, GERTRUDE E. CASE, STEPHEN MERRELL CLEMENT, AARON DAVIS, ERNESTO G. FABBRI, ELBERT H. GARY, WALTER L. GOODWIN, GEORGE A. GOSS, CLAIRE ADAMS HAMILTON, T. MITCHELL HASTINGS, RUSSELL A. HIBBS, ANSON P. S. HOYT, JOHN CHAMBERS HUGHES, FREDERICK E. HYDE, GEORGE H. INGALLS, EMMET W. IRVING, ROBERT JAFFRAY, HENRY R. KUNHARDT, BIRD LEWIS, MOSES TAYLOR.

Sister ST. RODRIGUE.

Misses MARJORIE E. ASHFORD, AUGUSTA P. DIXON, ELIZABETH W. EMMONS, IRENE ERISTOFF, MARY CECILIA FAIRFAX, BEATRICE GALLATIN, MARGARET H. GALLATIN, GERALDINE C. HALL, KATHERINE T. HALSEY, ISABEL HASTINGS, MARY LENA HAYDEN, SARA K. HUDSON, GRACE ELLIS TAFT.

Doctors KIRBY DWIGHT, WILLIAM W. HERRICK, BEVERLY C. SMITH.

Rear Admiral FREDERIC R. HARRIS.

Messrs. LISLE R. BEARDSLEE, CHARLES D. BREWER, ROBERT H. DELAFIELD, ALFRED ELY, MYRON S. FALK, LEIGH FRENCH, JR., SIMON GOODFRIEND, JAMES VARNUM GRAHAM, E. BAYARD HALSTED, T. A. HATCH, RALPH P. HINCHMAN, MILTON HOLDEN, NELSON C. HOLLAND, BURTON HOLMES, JOHN N. HOPKINSON, HENRY R. HOYT, DANIEL E. HUGER, RICHARD H. HUNT, RANDOLPH JENKS, CHARLES W. KELLOGG, W. FLOYD KENDALL, F. P. KEPPEL, DARWIN P. KINGSLEY, JR., WILLIAM KRIPPNER, A. NELSON LEWIS, ROBERT W. MALONEY, DANIEL MASOR, DON V. MESSER, HENRY MOIR, NOEL MORSS, CARL L. MULLER, JOHN O. RADWAY, C. S. SARGENT, LAWRENCE COPLEY THAW, JOHN W. THOMSON, A. L. MURPHY VHAY, ORLANDO B. WILLCOX.

Master JAMES M. MONTGOMERY.

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The Journal of The American Museum of Natural History

HAWTHORNE DANIEL
Editor

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A SCENE IN THE ALPS MOUNTAINS, NEAR ST. MORITZ, SWITZERLAND

Crevassed and weathered surfaces of the lower portion of the Pers glacier appear in the foreground, while in the upper levels the snow-covered ice cataracts (*Vadret da Pers*) lie between ridges of dark rocks. In the distant background gray clouds merge with the high snow-capped peaks of Pizzi di Palü, 12,040 feet above the sea. *See Page 379, "Living Glaciers"*

VOLUME XXVIII

NATURAL HISTORY

NUMBER FOUR

JULY-AUGUST, 1928

THE LORE OF THE DEMON MASK

How Savages and Barbarians Make Use of False Faces in Their Weird Religious Ceremonies. Ancient and Modern Uses of These Strange Masks Among the Natives of America and Other Parts of the World

By CLARK WISSLER

Curator-in-Chief of Anthropology, American Museum

THE use of "false faces," or masks, is an old trick of the human race. The museum visitor, viewing the weird and often grotesque masks on exhibition, may be moved to speculate as to the meaning of these caricatures and to wonder why so much space is allotted them. For example, an exhibit concerning the Iroquois Indians of New York is certain to contain a number of curious masks, because these Indians maintain a unique society for men known to us as the False Face Society. This name calls attention to the most striking outward feature of this society, the wearing of masks, such as are shown in the cover design of this number of NATURAL HISTORY.

There is something impressive in Iroquois "false faces," as many museum visitors have testified; they have a striking individuality, especially in the treatment of the eyes and the mouth. Carved from single blocks of wood, with cavernous eye holes, strong nose, and protruding lips, the face framed in with long hair falling loosely from a wig: such images peering from the shadows of the open fire, around which Indians love to gather, impress themselves too deeply upon the mind to be forgotten. Those of our readers who saw the play "Hiawatha," as presented some years ago, or the film made from it, will recall the striking entry of the False Face dancers, their slouching gait, and above all, their strange, awful mien.

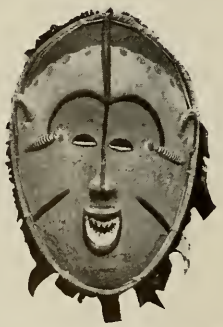
But the Iroquois are not the only Indians who use masks; on the contrary, the practice is widespread. The totem-pole makers of Alaska and Vancouver Island also are celebrated for their wooden masks, which far excel in variety and size those of the Iroquois. Visitors to the American Museum collections may recall these wooden masks, painted in black, red, and green, especially a few huge masks, seemingly too large and heavy for one person to support.

The masks of the Iroquois represent faces essentially human, whereas these larger masks of the totem-pole makers depict animal and bird monsters. Not infrequently the jaws of these masks are hinged so that the dancers can open and

TWO MASK CEREMONIES OF THE NAVAHO INDIANS
At the left a man masked to represent a god is driving out disease by shaking his rattle over the patient, while the naked youth at the right is a novice undergoing an initiation rite

close them at will, and often when the mouth of the mask is opened in this way, a human face appears within. This is not however, altogether a matter of fancy for throughout the myths of primitive folk runs the idea that those who have power can change at will from human to animal form and back again.

Thus the frequent reader of Indian tales is familiar with such incidents as "Now a raven appeared and spoke to him, but as the raven came nearer, it became a person standing there." Certain large wooden masks of the Indians of Vancouver Island are so constructed that the dancers are able to demonstrate such a supernatural transformation of the mythical raven into a person; the outward forms of these masks represent the raven, but when concealed cords are pulled, the wearer of the mask opens the raven face, and that of a human appears inside. Few peoples have carried this idea out so ingeniously in the construction of their masks as have these wood-carving Indians of Alaska and the Canadian Coast.



NEW IRELAND
CEREMONIAL MASK

J. G. Swan, one of the early visitors to these Indians, writing as an eyewitness, says,

> . . . The masks are made of alder, maple, and cottonwood; some are very ingeniously executed, having the eyes and lower jaw movable. By means of a string the performer can make the eyes roll about, and the jaws gnash together with a fearful clatter. As these masks are kept strictly concealed until the time of the performances, and as they are generally produced at night, they are viewed with awe by the spectators; and certainly the scene in one of these lodges, dimly lighted by the fires which show the faces of the assembled spectators and illuminate the performers, presents a most weird and savage

spectacle when the masked dancers issue forth from behind a screen of mats, and go through their barbarous pantomines. The Indians themselves, even accustomed as they are to masks, feel very much afraid of them, and a white man, viewing the scene for the first time, can only liken it to a carnival of demons.

A MASK FROM JAVA

However, it was not alone the totem-pole-carving Indians of Vancouver Island and Alaska, who indulged in such impressive and picturesque pastimes, for the Aztec of Mexico, their predecessors, and the prehistoric Maya of Yucatan, seemed to have specialized in masks. The former have left behind a number of curious manuscripts in picture writing, showing gods and heroes wearing masks. The Maya were expert carvers in stone, covering their temple walls and stone monuments with carvings in low relief, among which may now and then be seen masked figures. Nor was it only among the peoples of the Americas that such masks were used, they were used in the Old World as well. In present-day China, India, Java, etc., one meets with processions and festivals in which masked figures play the chief rôle, for the most part survivals of ancient customs.

Often when observing a custom so widespread as the use of masks, the thought arises that here is something of special importance in the life of man, and a custom whose beginning dates back to the dawn of civilization. At any rate, a custom that appears to be world-wide and an-

PUEBLO INDIAN ALTAR SHOWING REPLICA OF MASKED DANCERS IMPERSONATING GODS

INDIAN IN KACHINA DANCE COSTUME
From a painting by Louis Akin

cient seems to be worthy of serious study.

Turning again to the Iroquois Indian False Face Society, we note that there are in this company at least four classes of false faces: doorkeeper faces, those worn by doctors when treating the sick, the beggar masks, and what are spoken of as secret masks. Many individual masks have names according to the mythical being they represent, usually certain stone giants that play a large rôle in the beliefs of these Indians; one of the myths accounting for the origin of the Go-gon-sa false face was recorded by Mrs. Harriet Maxwell Converse as follows:

It could see behind the stars. It could create storms, and summon the sunshine. It empowered battles or weakened the forces at will. It knew the remedy for each disease, and could overpower Death. It knew all the poison roots and could repel their strong evils. Its power was life, its peace the o-yank-wah, the tobacco which drowsed to rest. The venomous reptiles knew its threat and crept from its path. It would lead the young hunter back to his people when the Stone Giant directed. It said: 'My tree, the basswood is soft, and will transform for the molder. My tree wood is porous, and the sunlight can enter its darkness. The wind voice can whisper to its silence and it will hear. My tree wood is the life of the Go-gon-sa. Of all in the forest there is none other.'

With this knowledge, the young hunter started on his way carving go-gon-sa-so-oh, (false faces). From the basswood he hewed them. By the voice of the Stone Giant he was guided to choose; and well he learned the voices of all the forest trees before he completed his task.

In his travels he met many strange animals and birds, which he detained until he had carved them in the basswood; and inviting them to tarry, learned their language and habits; and though fearing the Giant's reproval, for he constantly heard his voice encouraging or blaming, he learned to love these descendants of his ancestors, and was loath to leave them when compelled to return to his home.

Many years had passed in the laborious task, and he who entered the cave a youth, had become a bent old man when, burdened with the go-gon-sas he had carved, he set out on his return to his people. Year after year his burden had grown heavier, but his back broadened in strength, and he had become a giant in stature when he reached his home and related his story.

JAVANESE FESTIVAL MASK

In a general study of masks, the first questions to arise are, "What place do masks hold in the interest of primitive peoples? What kind of ideas and beliefs are associated with them?

If we begin with our own civilization and time, we see the mask as a frivolous object; the clown or the silly buffoon may use it to heighten his grotesqueness; children and young people may use masks on fête days to amuse adults and to frighten the timid. Occasionally they are still used upon the stage when some of our ancestral folklore is to be enacted.

Yet, on the whole, the mask is to us something childish, something scarcely to be considered respectable. Consequently, when we stand before a museum case, or look over the pictures in a book, we are puzzled how to justify the attention given to the subject of masks by serious-minded people; we may go even further and assume that the people who made and used these masks were infantile in their interests, so far benighted as to be beyond understanding. This is in keeping with one of our bad intellectual habits, viz., attributing our own ways of thinking to the savage mind. Because we put no value upon masks, tolerating them only in light, frivolous associations, we fail to see how savages could regard them otherwise, even such savages of ancient Europe as were our ancestors.

PLAINS INDIAN DOG DANCER
Drawn by Bodmer

JAVANESE FESTIVAL MASK

When seriously used, masks are part of the regalia worn in savage ceremonies, chiefly religious. Such ceremonies may have many features, but most of them possess regalia and a ritual in which are songs and dances. Here, again, we often misjudge the savage, for to us a dance is anything but religious, and so his dancing upon such occasions, if it does not shock us, at least provokes pity for his lack of understanding. On the other hand, anthropologists who specialize in the study of primitive life, find in the regalia, songs, and dances what they regard as important

SUN DANCE OF THE ARAPAHO INDIANS

Masks are not used, but the faces of the dancers are painted. This particular type of ceremony was common among the Plains Indians, particularly of the northern plains, but was unknown among the woods dwellers

data for the understanding of human life.

If the reader goes to a library and asks for special publications upon the American Indian, for example, long detailed studies of ceremonies will be given to him, describing minutely just how the participants were dressed, what they did, sang, and danced; further, an attempt will be made to explain the meaning of the ceremony. Any reference librarian can give a long list of such books, which means that many tribal ceremonies have been studied in every part of the world — Asia, South America, Australia, Africa, and elsewhere —and looking over these detailed descriptions of savage ceremonies, one finds them much alike.

No matter to what part of the world we turn, we find the belief that these ceremonies, songs, and dances were not designed by man, but were given to him ready made and in some mysterious fashion, just as in the case of the Iroquois Indian who started the False Face Society. Someone, at some time—usually in the good old times now passed — met a supernatural being who taught him the whole ceremony.

BELLA COOLA MASK FROM BRITISH COLUMBIA

For example, an interesting Indian tale recounts the experiences of a young man who wandered out alone. Coming at last to a place where the beavers had a dam and their houses in the water, he sat down to meditate. These beavers, he thought to himself, must possess some extraordinary power to do as they

do, and so he resolved to sleep there, hoping that the chief of the beaver might take pity on him and help him to attain to a place of power and respect among his own people. That night a beaver appeared before him, turned into a person, and invited him to follow; they passed down into the water and into the house of the beaver. It was a great lodge and his guide was the chief of all the beaver. Here the young man saw many beaver and here he stayed throughout the winter as the guest of the beaver. When spring came, however, the young man expressed a wish to return to his people. So the beaver called into his lodge all the head beaver and, becoming like people, they performed a ceremony, teaching the young man the songs, dances, etc. Then he was conducted to the dry ground, to his old camping place, and so returned to his people, where he started the ceremony he learned from the beaver.

BELLA COOLA MASK FROM BRITISH COLUMBIA

When we review this tale, we note, first, that there appeared to the Indian a beaver which took on human qualities, because it spoke to the Indian and conferred upon him powers and imparted information, and so the Indian started a ceremony. But what is this ceremony like? It begins with a narrative like the preceding; then the leader of the ceremony takes

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IROQUOIS FALSE FACE SOCIETY ENTERING THE DANCE LODGE

The cover painting of this issue of NATURAL HISTORY shows another aspect of a dance by these masked Indians

DOUBLE MASK USED BY THE HAIDA INDIANS

CEREMONIAL MASK OF A NORTH PACIFIC COAST TRIBE

the part of the beaver, other participants are the beaver's helpers and, finally, one person takes the place of the original hero, who is said to have been received into their lodge by the beavers. The ritual which follows is supposed to repeat the events, step by step, by which the beaver conferred this ritual upon the first Indian. In other words, the incident is staged with an appropriate cast and the participants become, in a way, players presenting a drama.

This not only applies to this particular ritual, but is well-nigh universal among mankind, primitive and civilized. Naturally rituals and symbolic procedures believed to have originated with mythical beings cannot well be demonstrated except through the impersonation of these mythical beings who, as we have stated, while often conceived of as animals or birds, are also human, having a kind of alternating personality, exceeding the power of real human beings as well as animals in that they can change their bodily forms and do other things impossible for either animals or humans.

The wearing of a mask is the usual method of impersonating these mythical human beings or their animal counterparts. When the American Indian impersonates the buffalo, he may put the skin of the head over his own head, and look out through the eye holes; the effect may be heightened by having the whole skin fall over the shoulders of the wearer and down the back, the characteristic buffalo tail dangling below. Also the bear plays a part in the myth-

MASK FROM BAKETE, AFRICA

ologies of many peoples and so is impersonated with great frequency; sometimes the face of the bear is realistically carved in wood, to which the skin of a bear is attached; drawing this over his head, the savage will crouch and growl, and by skillful acting give a satisfactory representation of a bear.

A spirited description of a masked Indian dance is given by George Catlin, the famous Indian traveler:

My ears have been almost continually ringing since I came here, with the din of yelping and beating of the drums; but I have for several days been peculiarly engrossed, and my senses almost confounded with the stamping, and grunting, and bellowing of the buffalo dance. . . .

Every man in the Mandan village is obliged by a village regulation to keep the mask of the buffalo hanging on a post at the head of his bed, which he can use on his head whenever he is called upon by the chiefs to dance for the coming of buffaloes. The mask is put over the head, and generally has a strip of the skin hanging to it, of the whole length of the animal, with the tail attached to it, which, passing down over the back of the dancer, is dragging on the ground. When one becomes fatigued of the exercise, he signifies it by bending quite forward, and sinking his body toward the ground; when another draws a bow upon him and hits him with a blunt arrow, and he falls like a buffalo—is seized by the by-standers, who drag him out of the ring by the heels, brandishing their knives about him; and having gone through the motions of skinning and cutting him up, they let him off, and his place is at once supplied by another, who dances into the ring with his mask on; and by this taking of places, the scene is easily kept up night and day.

DOUBLE MASK FROM BRITISH COLUMBIA

CEREMONIAL MASK FROM VANCOUVER ISLAND

WOODLAND INDIAN MASK

That dancing with an animal mask is an old, old, custom, is shown by certain Stone Age pictures upon the walls of caves in France. One of these shows a dancer wear-

MASK FROM NEW IRELAND

ing the skin and head of a deer, while in another cave are three dancers in a row, with heads and skins of chamois, or similar animals. These last seem to be dancing by jumping up and down, holding the feet together, as do the native women in Australia when imitating the kangaroo.

A TIBETAN MASK

As a rule, the steps in these dances are simple, but body movements are emphasized. The dancer is not merely enjoying the rhythm and excitement of the procedure, but may well be dancing as the impersonator of the animal or hero figuring in the ritual of the occasion. The swaying movements, the strutting and the stooping, are all conceived to be representative of the leading animal or hero. A particularly forcible illustration of this is to be seen in the Eagle Dance of our Southwestern Indians as, covered with down like an eaglet and with rows of feathers down the arms and a tuft for a tail, the dancers, in stooping position, simulate the soaring of the eagle.

Assuming that these masks originally developed from a simple beginning, we may properly ask as to the nature of that simple first step. However, while everyone is interested in the origins of human customs, such origins are so elusive that many serious-minded students of the subject are inclined to doubt the possibility of finding them. Thus it has been proposed that masks were first the heads of animals; again, a device for frightening children, an outgrowth of designs upon shields, painted designs upon the face, etc. All of these guesses are plausible, but as no record of the beginnings of the

FROM KASENGA, AFRICA

mask have come down to us, there seems little hope of finding the truth about the matter. We can, however, conclude that it is an old custom, known in some form to most peoples.

Yet, though we may never be sure of how masks came to be so widely used, it is not difficult to see that they offer a medium for art expression. We have referred to the Indians of Alaska, experienced carvers of wood, who have produced a number of masterpieces, many of which, though usually grotesque, are highly realistic. But for richness in conception and wealth of detail nothing seems to surpass the turquoise mosaic masks of the Aztec, in which the whole surface of the wooden mask base is overlaid with designs built up from minute bits of turquoise and other colored materials. That the earlier Maya used equally fine masks is shown by their low relief sculptures in which warriors and priests stand forth in masks and plumes. Not infrequently the sculptor, in presenting a profile, shows the face of the wearer behind the mask. If the reader imagines the great ruined Aztec temples, topping pyramids in their original grandeur, with highly decorative serpent columns, with brilliant wall paintings representing processions of plumed warriors and priests, and then in imagination tries to see the priests officiating at the altar, wearing masks encrusted with turquoise and topped by rich plumes, he will have some idea of the artistic heights to which the mask and the staging of rituals were carried in prehistoric America.

BAMPENDE MASK, AFRICA

A KORYAK MASK FROM SIBERIA

WEST AFRICAN MASK

If we turn to the Old World, the paint-

A BELLA COOLA MASK
(Closed)

A BAKUBA MASK FROM
AFRICA

ings upon the walls of temples and tombs in Egypt present priests masked to represent the gods of that religion; further, the temples of India and China present many masked images. The reader interested in the artistic aspect of masks and their relation to the theater should look up that interesting book by Kenneth MacGowan, *Masks and Demons,* in which are many good illustrations of masks, with descriptive notes.

Turning now to more prosaic problems in the use of masks by the aboriginal Indian population, some curious facts in their geographical distribution are noted. Among the Indians east of the Mississippi River and near Hudson Bay, the Iroquois were not the only ones who specialized in masks. Some use of them was made by the Cherokee, Delaware, Nanticoke, Ojibway, and Choctaw, and probably by many others. West of the Mississippi, among the Indians of the Plains, the heads of the buffalo, the bear, and other animals were sometimes worn in appropriate ceremonies, but carved masks have not been reported.

On the other hand, the western belt of high land from the Arctic to Panama is conspicuous for the use of masks. As we have stated, the practice was highly developed in Mexico and Central America, and again among the Indians of lower Alaska and the coast down to the Columbia River. Even the Eskimo of Alaska, and as far east as Hudson Bay, made use of masks.

Turning back to California, we find almost no masks, but among the Indians of Arizona and New Mexico again the cus-

IROQUOIS MASK

tom comes to the fore, the best known masks being those worn in the kachina ceremonies.

In South America, there were several highly developed civilizations in the Andean highlands, the best known being that of the Inca in Peru. There is good reason to believe that the Peruvians used masks, but these do not occur in collections; nevertheless, upon pottery, and occasionally in textiles, we observe what are certainly masks, some elaborate and some grotesque. The descendants of the Peruvians even now appear on certain Christian festival days in masquerade costumes that seem to be pagan. Of special interest, however, is the placing of masks upon the faces of the dead, not only in Peru, but in the whole of the Andean highland region from the Isthmus of Panama to northern Chile. Museum visitors are no doubt familiar with the mummy bundles from Peru, with their quaint wooden and woven faces.

A BELLA COOLA MASK
(Open)

CHINESE CEREMONIAL MASK

Leaving the Andean highland and turning to the lowlands of Brazil, we meet with many reports of masked dancers. The shapes are usually those of the jaguar, alligator, tapir, birds, insects, etc. In some cases wooden masks are used, but usually they are of bark, are kept out of sight of women and children and, after the ceremony, are carefully burned. While data for many tribes in the lowlands of South America are lacking, yet, from what we have, it appears that dancing masks occur from Tierra del Fuego on the south to the Orinoco River on the north, but are infrequent in several parts of Argentine and Brazil.

IROQUOIS MASK

It is difficult to summarize this distribution in a sentence, but the intensive use of masks is more frequent in the western highlands of the two Americas, than in other sections.

The most elaborate and also the most artistic masks were, as may be expected, among the old native civilization of Peru in South America and of the Maya and the later Aztec in Mexico and Central America. Among the simplest and crudest were those of the Eskimo of the far north and of the Ona near Cape Horn at the lower end of South America. Thus, the Ona usually cover the head and face with a piece of rawhide upon which are painted a few spots in color to symbolize the spirit represented. One particular mask of this kind, according to the descriptions of observers, bore red and white spots, the emblem of the god of the heavens. Shifting to the far north the Eskimo around Hudson Bay use a few simple masks of skin, rather loosely fitted to the face and bearing simple markings.

ANIMAL MASK FROM CENTRAL AFRICA

We mention these outlying examples to emphasize the wide distribution of the masking idea. Also, wherever used, the mask is intended to represent a spirit, or a supernatural being, and is thus an aid to the impersonation of these mythological personages. The primary association of the mask is therefore with serious religious practices, rather than with entertainment and esthetic effects, suggesting that the masked dances and stage effects of civilized peoples also have a serious religious background.

FROM VANCOUVER ISLAND

Midnight on the shores of Great Slave Lake

CANADA'S LAND OF THE MIDNIGHT SUN

The Great Valley of the Mackenzie River and the Northern Coast of Canada.—The Indians and the Eskimos, the Rivers and Lakes, the Products and the Administration

By O. S. FINNIE

Director, North West Territories and Yukon Branch, Department of the Interior, Canada

ONE million three hundred thousand square miles of Canada lying north of "sixty" are known as the North West Territories. They extend easterly from the delta of the Mackenzie River to Baffin Island, a distance of approximately two thousand miles, and reach more than fourteen hundred miles from north to south, from Cape Columbia to latitude 60° N., including all the islands in the Canadian sector as far as the Pole.

Neither the natives, nor the fauna, nor the other resources of so vast a country can be adequately described in a short article. From agricultural lands in the southern areas the country stretches to the world's most northerly headland; the natives include Indians and Eskimos speaking three distinct languages and living under as many sets of conditions; the wild life covers almost every species of land and sea mammal known to Canada, and the other potential resources of the Territories are found under a variety of conditions that differ in climate and accessibility.

The District of Mackenzie, the most important of the three main divisions of the North West Territories, can be most readily approached by the route leading north by rail from Edmonton, Alberta, to the southern watershed of the Mackenzie River. Fort Smith, the administrative center within the district, is situated on the Slave River in latitude 60° N., where a series of rapids forms a barrier to river navigation. At this point we find ourselves in the land of the Chipewyan Indians.

Should we listen to the casual conversations of the crowd, we would hear English, French, Cree, and Chipewyan used impartially, for although the language of the district is Chipewyan, the Crees from the south are well represented, and the traders and missionaries are chiefly of British and French extraction.

Fort Smith, situated on a high, sandy plateau, overlooking the river, is typical of

NORTHERN CANADA

Fort Smith is the headquarters of the administration of the North West Territories. From this trading post three routes lead north. The most important is northwest by way of Great Slave Lake and the Mackenzie River. Another leads north through Rae, and the third leads northeast through Great Slave Lake past Reliance

many of the northern posts—its principal features being Government offices, a Royal Canadian Mounted Police post, a wireless telegraph station, a mission church and house with hospital and school, and establishments of the principal fur traders of the north. To these should be added the log homes of the natives and a host of dogs which constitute the motive power of the country's winter transport. In winter Fort Smith is dark and bleak and wind-swept, and in summer it is a noted gathering place for all varieties of insect pests known to the northland, while for weeks, daylight never fades entirely from the sky.

Immediately to the west lies a country of alternate swamps and low sand ridges, difficult of access, but valuable because it has given perfect protection to the only remaining herd of American bison that has never known captivity. In 1901, the Dominion Government prohibited the killing of these animals. An estimate made about twenty years later placed their total at approximately fifteen hundred. To these have been added recently six thousand young buffalo from Wainwright National Park, and it is confidently hoped that the next decade will see an increase in their numbers great enough to make them an important factor in the food supply of the District, and possibly to warrant licensed hunting under the supervision of official game guardians.

The fur resources of the Fort Smith area have been intensively drawn upon for more than one hundred years, but still the trapper thrives. Each winter yields pelts of bear, wolves, lynx, colored foxes, fisher, otter, marten, mink, skunk, and muskrat—fox, mink, and rat predominating. It is possible, however, that the time is not far distant when fur farming will bring to many a better living than is to be secured today from the taking of wild animals.

From Fort Smith to the Arctic Ocean, a distance by water of fourteen hundred miles, river transportation is uninter-

rupted. Large and comfortable steamboats serve the public, and already the excellence of their service, the novelty of the life of the lower river settlements, and the river scenery have popularized them among those on the outlook for summer tours in little known lands.

Two hundred miles of river, winding slowly through the country of the buffalo and the moose, lead from Fort Smith to Great Slave Lake. One legend of the source of the name "Great Slave" tells how, even before the advent of the trader, a white child was sold as a slave to an Indian tribe which had its home on the shores of the lake. The child grew to be a man above the ordinary stature, with long, fair hair and light-blue eyes, who lived a long life among his Indian masters. His presence led to the area being known as the "land of the great white slave," eventually abbreviated to Great Slave. The story further states that the child slave was the rightful heir to the throne of France—an interesting echo of the rumors spread by the devotees of Napoleon that the son of Marie Louise had not really died at Vienna but had been spirited away by the wily Metternich.

Another legend, quoted by the Geographic Board of Canada, is to the effect that Great and Lesser Slave lakes and Slave River were named after a tribe of Indians that once dwelt in that region. These Indians called themselves *Etchareottine*, which means "the people dwelling in the shelter of the (Rocky) mountains." In contradistinction to other northern Indians, who were caribou eaters and traveled widely in pursuit of game, the *Etchareottines* were fish eaters and kept to the lakes. When the more warlike Crees went on the warpath against the tribes on the Peace River, they came from

FORT SMITH FROM THE AIR

This trading post is situated just over the southern border of the North West Territories beside the Slave River and at the lower end of the heavy series of rapids that break river transportation at that point. Mr. Finnie is Director of the North West Territories and Yukon Branch, and this settlement, being his headquarters during the summer, must be viewed as the capital of the district

DRYING FISH AT "HAY RIVER"

Because dogs still form the most important motive power for winter transport, fish must be caught and dried in large numbers, for this is the only food given to the dogs during the long winters. In every northern trading post, drying racks of this kind are numerous

the south in canoes to Lesser Slave Lake and, leaving their canoes there, proceeded overland. Finding that the lake-dwelling Indians did not possess their own warlike attributes and ideas, the Crees showed their contempt by bestowing on the lake-dwellers the epithet "awonak" or "slaves."

By way of Great Slave Lake the traveler reaches the land of the Slave Indians, and to the babel of tongues is added still another dialect. Resolution, the most important settlement on the southern shore, is the meeting place of the Indian trappers from east and west, north and south. The southern Indians, the Crees and Chipewyans, are represented chiefly by the imported servants of the traders, this point marking the northern limit of the influence of both these nations. Three highways lead from Resolution, one to the northwest following the waters of the Mackenzie to Beaufort Sea, one due north to the country of the Yellow Knife Indians, and the third east to the lakes and plains of the Arctic prairies and the home of the caribou and musk ox.

To the east, a cruise of two hundred miles along the shores of Great Slave Lake —one of the great lakes of the world with an approximate area of 11,500 square miles—brings the traveler to Fort Reliance. From this point the trail leads overland until the headwaters of rivers flowing to Hudson Bay are reached. Here are the great Arctic prairies, a country well dowered by Nature except with trees.

From any point of vantage can be seen an apparently endless series of rolling hills plentifully endowed with grass, moss, and Arctic flowers. Sparkling lakes nestle in the valleys, and winding streams disturb the quiet of the scene as they tumble their way down their many rapids

to mingle their waters finally with those of far-distant Hudson Bay.

This rolling country is the home of the caribou, the wolf, the Arctic fox, and the remnants of the few remaining herds of musk ox to be found on the mainland. The streams and lakes are plentifully stocked with fish, and their shores are the nesting grounds of many varieties of water fowl. The potential wealth of this Arctic plains area lies in its undoubted ability to yield liberal supplies of meat and hides from caribou or other hardy animals, fish from its waters, and fur from its hills.

Humanity is but poorly represented on the Arctic prairies. A small band of Indians, who winter along the northern fringe of timber, each spring follows the caribou in their northern migration, and lives entirely upon caribou meat and fish. Eskimo from the shores of Coronation Gulf to the northwest, and coastal points to the eastward, move each spring toward the Thelon River to meet the same migration on its way to the Arctic coast. The only permanent residents are three bands of Eskimo who base their operations on the shores of Kasba, Sigoligjuak, and Baker lakes, from which points they eke out a living from the eastern sections of these northern plains.

Recently the Dominion Government set aside a large area, surrounding the confluence of the Hanbury and Thelon rivers, as a game sanctuary wherein all wild life indigenous to the country, and especially the musk ox, would have a haven of refuge from hunters, both white and native. This sanctuary contains an area of about 15,000 square miles.

Starting again from Resolution, another road leads to Rae, on a northern arm of Great Slave Lake, and the land of the Dog Rib Indians. In 1821 Franklin and

ONE STEP IN TANNING A HIDE

This Indian woman, who is a resident of Arctic Red River, which lies north of the Arctic Circle, is engaged in cleaning the hair from a hide by means of pulling it over the dull edge of the stick that she has thrust into the ground

A "LOB STICK" NEAR FORT McKAY

In order to mark trails, caches, and camps, and in order sometimes to erect memorials to former residents of the district, these "lob sticks" or "lop sticks" are prepared. Branches are lopped from the tree in such a manner as to leave it distinctive, and the trees that are so prepared usually are chosen because they stand in some conspicuous place

his party followed this route to the north. A winter camp was built half way between Great Slave and Great Bear lakes, which was known as Fort Enterprise. From this point a season was spent in exploration of the Coppermine River and the shores of Coronation Gulf. Part of this route was also followed by Hearne of the Hudson's Bay Company, when from 1769 to 1772 he pioneered the valley of the Coppermine River. One of the great tragedies of the North was enacted during this trip, when the Indians who accompanied Hearne massacred more than twenty defenseless Eskimo men, women, and children, camped at a point since known as Bloody Fall, on the lower reach of the Coppermine.

During the past winter a unique event occurred in the vicinity of Fort Enterprise about 150 miles north of Great Slave Lake, the spot where Sir John Franklin, with Lieutenant Back, spent such a terrible year of hunger and privation in 1821 and 1822. Two years ago, while an official of the Canadian Government was making a patrol from the bottom of Bathurst Inlet, five hundred miles over a bleak and desolate territory to Rae, he had with him a young Eskimo youth from Coronation Gulf. They had many adventures on the way but, on reaching Rae, the young Eskimo was delighted at what appeared to him a veritable metropolis, although it cannot boast of more than half a hundred people.

So enamored with the place was the youth that he wanted to remain, forgetting entirely the pretty wife he had left in a distant igloo. The official, however, had no intention of permitting the youth to remain, for, had he done so, the lad's tribesmen would have assumed that the white man had killed him, and so would probably have taken his own life in retaliation.

When they finally returned to Bathurst Inlet, the young native must have told his tribesmen how well they had been treated by the Indians and, as a result, the Eskimo in a body appeared shortly after Christmas at Fort Enterprise. Here, though face to face with their traditional enemies the Indians, a ten-day powwow of feast and dance took the place of bloody war.

It was the first occasion on record where groups of Eskimos and Indians from these districts have buried the hatchet, and is in marked contrast to the warlike attitude at the time of Hearne.

The Dog Rib Indians are one of the larger tribes of the North. Long association with the white trader has advanced them to a life of semi-civilization, but they still depend upon the wild life of the country for an existence. As they wander over a wide country of rocky hills, some of which are timbered, though sparsely, their harvest consists of fur, fish, caribou, and moose, with rabbits to fill in the periods when larger game is not available. Much of this area has been reserved by the Government of Canada as a hunting and trapping ground for the exclusive use of the natives.

To the west and north of Resolution lies the valley of the Mackenzie River. "Hay River," a settlement lying near Great Slave Lake in the broad valley of the river from which the community takes its name, is the home of a well conducted boarding school, two missions, and several trading establishments.

Providence lies on a level plain on the bank of the Mackenzie. The buildings of the Royal Canadian Mounted Police, of the mission with its boarding school for native children, and of the several trading companies, are practically the only permanent structures in the settlement. At points farther south the Indian and half-breed trappers have built for themselves cabins from which they pursue their activities, but the natives of the Providence district are still the itinerant people of a hundred years ago. Many of them are born, live, and die in their native tipis and brush camps.

Between Providence and Simpson on the way north, the river narrows and runs swiftly, but navigation is uninterrupted. Simpson is located on a large island just below the confluence of the Liard and the Mackenzie rivers. It is one of the larger

ALEXANDER FALLS, HAY RIVER

This waterfall, which is located about thirty miles up the Hay River from Great Slave Lake, is about 190 feet in height, and it is estimated that 80,000 horsepower could be generated if a hydroelectric plant were installed

ARCTIC RED RIVER

This post, which lies beside the Mackenzie River just north of the Arctic Circle, is in the land of the Loucheaux Indians, though Eskimos are occasionally to be seen here as well

A CACHE AT FORT MCPHERSON

McPherson lies on the Peel River well to the north of the Arctic Circle. In order to protect supplies from the ravenous dogs that abound at such posts, caches similar to this are often built

A MACKENZIE RIVER STEAMER AT FORT NORMAN

In the distance stands Bear Rock, which marks the confluence of Great Bear River with the Mackenzie. The steamer in the foreground is operated by a trading company

A VIEW FROM THE TOP OF BEAR ROCK

Looking to the west across the Mackenzie. The river is four miles wide at this point. Throughout its entire length the Mackenzie is navigable for large river steamers

LOUCHEAUX SQUAW AND PAPOOSE
These Indians live in the vicinity of Arctic Red River

settlements of the Territories, and was at one time the trade headquarters for the whole valley of the Mackenzie. Originally a typical Hudson's Bay Company fort, dating from the early days of the last century, it has grown to be a prosperous settlement with missions, hospitals, schools, a Royal Canadian Mounted Police post, a Government wireless station, a number of trading establishments, and a Government Indian Agency which conducts an experimental farm. The surrounding country, consisting of rolling hills lightly covered with timber, has up to date produced little but fur, though it is not without promise for the future. The Rocky Mountains are less than one hundred miles to the northwest, and far back in the mountains lies a valley about which little is known beyond the fact that in it hot springs are so numerous that its temperature has been materially affected. While the surrounding country suffers from a somewhat rigorous climate, the "semi-tropical valley," as it has come to be known, sees but little snow, and is the winter home of a great variety of wild life.

The Liard River is the highway serving the territory to the west. It boasts of a steamboat service, adequate to the needs of the country, which each year carries a wealth of high-grade furs to the markets of the world. The upper reaches of the Liard, penetrating far into the mountain ranges, connect through British Columbia with established routes of travel leading to the Pacific coast.

Sixty miles below Simpson the Mackenzie enters a bolder and more rugged country, and for many miles the traveler is regaled with true western mountain scenery. When the river swings back to the foothills, Wrigley, a fur post active enough in winter but presenting little of interest during the open season, is passed, and the journey is continued to Norman. This settlement stands on the high banks of the Mackenzie at the mouth of Great Bear River. The usual essentials of a northern post are here in evidence. The

COPPER ESKIMO WOMAN
From the vicinity of Tree River

country, east and west for many miles, is tributary to this post.

The Great Bear River is the highway to Great Bear Lake and the country beyond as far as Coronation Gulf, while to the west an overland trail follows the valley of the Gravel River to the headwaters of the Stewart River and on to the Yukon. The Great Bear River is shallow and swift, but can be ascended by suitably constructed power boats. Great Bear Lake is the largest lake in the northland, covering an area of something like 12,100 square miles, but its use as a transport route is limited to not more than three months in each season, as it is ice-bound for the rest of the year.

AK-KO-A, WHOSE NAME MEANS "STERN OF BOAT"
This Eskimo is an Aiviligmiut native from Repulse Bay

Much of interest centers around Norman. Not only is it the trade center of a large and productive district, but the scenic and mineral resources are also outstanding. A few miles from the settlement lie lignitic coal beds of doubtful commercial importance but spectacular, having burned continuously at least since the first exploration of the river by Mackenzie in 1789. To the north of the post lies a prominent mountain known as Bear Rock, and along the western horizon lie the bold peaks of the Rocky Mountains. The burning of the coal seams and the three peculiar red stains, probably caused by oxide of iron, which show on the face of Bear Rock, have given rise to a typical Indian legend.

Many years ago, according to the story, both the people and the game of this area were giants of their kind. A giant hunter armed with bow and arrow, while standing on Bear Rock, saw a colony of giant beaver in Bear River. With his arrows he secured three of these, but several of his arrows which had missed their mark remained embedded in the river bottom, with one end still showing above the water. As in all the northern rivers sunken trees are to be seen, the story-teller points out the giant arrows without difficulty. The hunter then skinned three of the beaver and spread the skins on the face of Bear Rock to dry; the blood left the three stains in the shape of the three beaver skins. Taking some of the beaver meat to the point where the coal now burns, the hunter made a fire to cook a meal, but the fire burned so fiercely that the ground became ignited and has been burning ever since.

Fifty miles below Norman there is every evidence of an oil field of economic importance, but the cost of a pipe-line or other means of transportation prohibits, for the present, its development on any major scale. It has given promise enough to suggest the establishment of a small

LOADING WOOD ON THE MACKENZIE RIVER
All the steamers of the Mackenzie burn wood, and such scenes as this are common during any trip on the river

refinery for the production of gasoline and oil fuel to supply the local demands.

Farther north the river flows through a cañon known as the Ramparts, whose white limestone walls rise one hundred and fifty feet above the water. From the foot of the Ramparts, Good Hope can be seen crowning a high point on the eastern side of the river. This settlement is sixteen miles south of the Arctic circle, and is a large and prosperous fur-trading center. It is also the northern limit of the Hare Indian nation, as at the next settlement (Arctic Red River) their language will be understood only with difficulty, that of the Loucheux tribe having taken its place.

The settlements of Arctic Red River and McPherson are the trading centers of a country entirely apart from the valley of the Mackenzie to the south. McPherson was established early in the last century, and was at one time the gateway to the Yukon valley. An eighty-mile portage across a comparatively low-lying country leads to the headwaters of the Porcupine River, which joins the Yukon at Fort Yukon. The delta of the Mackenzie marks the northeastern limits of a group of Indian tribes which spreads south and west to the valley of the Yukon.

The most northerly post on the Mackenzie is on an island in the river delta that is known as "Aklavik," meaning in the Eskimo language "where the bear abounds." Here the sun in summer is visible throughout each of the twenty-four hours, and here is another important boundary between native races—the meeting point of Indian and Eskimo. Originally this area was controlled entirely by the Eskimo, but the Indians following the white men have extended their hunting grounds to the north, and the Eskimo are gradually retiring to the Arctic coast line.

Aklavik is also the junction of two

transportation routes, one of which follows the Mackenzie valley, while the other is the ocean route from Pacific coast ports which leads through Bering Sea and along the northern coast of Alaska. Both routes have their drawbacks. The cost via the river route is excessive, and on the ocean route there is the ever-present danger of loss of both ship and cargo when rounding the northerly capes of Alaska.

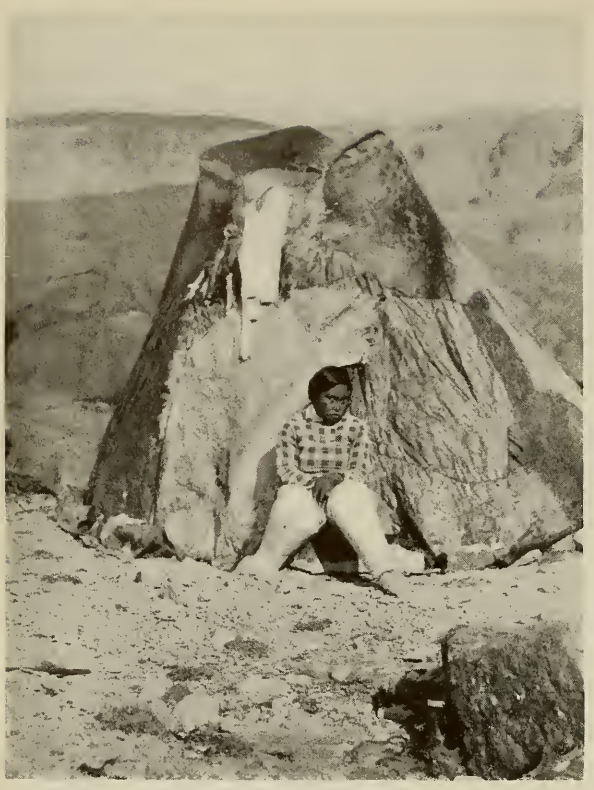
The shores of Beaufort Sea are still the undisputed heritage of the Eskimo. Between the Alaskan boundary and the eastern end of the delta of the Mackenzie lie four settlements—Demarcation Point Herschel, Shingle Point, and Kittigazuit—whose inhabitants, living largely on the resources of the country, draw their harvest from both land and sea. The hills produce caribou, which mean both food and winter clothing; from the lakes and streams the natives secure fish, while the ocean supplies more fish and various kinds of seal and white whale, which solve the problem of materials for boats, tents, and footwear, and add to the food supply. While tree life is no longer in evidence, the heavy drift from the Mackenzie has stored the beaches with fuel adequate for many years to come, placing the Eskimos of this area in a different position from their brothers to the east, who are largely dependent upon sea-mammal oil for heat and light.

Eastward from the Mackenzie, the Arctic coast line is navigable for many hundreds of miles, steamboat service reaching eastward to King William Island having been maintained for some years past.

The numerous native settlements scattered along the Arctic coasts of Canada may be considered under three territorial divisions—from the Alaskan boundary to Baillie Island, from Bernard Harbor to

PLOWING WITH A DOG TEAM

The trading post at Hay River is also the headquarters of an important Anglican Mission. Here Indian and Eskimo children are able to obtain education, and here, too, the missionaries are properly proud of their agricultural success, even though their products are limited



AN ESKIMO WOMAN IN FRONT OF A SKIN TENT
In winter these people live in snow igloos, but during the short, hot summers, all snow disappears, and skin tents are used

Boothia Peninsula, and from the western shores of Hudson Bay to the Atlantic. Until the advent of the white man, a barrier appears to have existed between the natives of Baillie Island and Coronation Gulf, and another, though not so absolute, separated the residents of Boothia Peninsula from those of Hudson Bay.

Both the eastern and western groups received their first impression of civilization from the whalers, while those of the central areas are only now drawing their first knowledge of the world from the fur traders from the south. The influences prior to the white invasion are still stamped on all, in clothing, accoutrements, and home life. These differences are, however, entirely regional; the language throughout the Eskimo world is basically the same; and a study of the folklore proves the common origin of the Eskimo people from Siberia to Greenland.

The Government of Canada is confronted with a complex problem in the administration of the Far North, but, in so far as it is possible, the various situations have been met as they have arisen. Communication is maintained by a well organized mail service and an efficient system of wireless telegraphy operating stations at Edmonton, in Alberta; at Fort Smith, Resolution, Simpson, and Aklavik in the North West Territories; and at Herschel Island, Dawson, and Mayo in the Yukon. Schools and hospitals are subsidized, relief is given to the sick and destitute, game sanctuaries are maintained where wild life is molested by no one, and many thousands of square miles of the territory are set aside as hunting and trapping grounds for the sole use of the native population. Government offices are maintained within the Territories, and law is enforced by Canada's efficient Royal Canadian Mounted Police.

Each year, as more complete information becomes available, the picture of the Northland, as it will appear in the not distant future, grows in interest. Today the Canadian Government subsidizes the Territories, not altogether in a spirit of philanthropy but as an investment from which it will draw ample dividends. The value of the natural resources of the country is undoubted. To develop them to the best advantage the coöperation of the native population is most essential, and the expense incurred in their care and improvement will be amply repaid.

A JUNGLE RIVER JOURNEY

Up the Amazon and the Rio Negro to the Strange Stream that Connects the Amazon Valley with That of the Orinoco.—The "White Indian" from the Padamo River.—The Comforts and Discomforts of Travel in the Interior of South America

By HERBERT SPENCER DICKEY

A LINE of really palatial steamers connects Pará with the towns of the upper Amazon. Screened staterooms with comfortable beds and running water, a large open-air dining saloon on the after deck, decent meals, good service, and a refrigerating plant, help to counteract the effects of the heat and the depredations of the ravenous mosquitoes and gnats that come aboard whenever the ship stops for wood.

Heavily subsidized by the Brazilian Government, the Amazon River Steam Navigation Company manages to run, provide us with comforts, and charge us the ridiculously low price of $12.50 for the thousand-mile journey from Pará to Manaos, meals included. With that we are content.

The Amazon color scheme may be said to be that of amber and emerald. The former is provided by the stream itself, which derives this color from the tons of slowly precipitating silt which are washed daily from the banks. The latter is provided by the dense forest which covers the low-lying land on either side of the river.

All the low land is subject to inundation at some time. The very low land, known as the *igapó*, is flooded with the slightest rise of the river. Higher land, the *vareza*, is flooded only when the river is very high. The highest land, the *terra firma*, is never inundated. It has a foundation of clay or rock, and here the occasional towns and villages, which are to the gigantic forest as a toy boat is to the ocean, have their being.

Tourists are invariably disappointed with the first thousand miles of the Amazon, which is as far as their ships go. With all the effort Nature has made to show what she can do in the way of flora, she has been decidedly remiss in the question of fauna, and has apparently made no attempt whatever to make the tourist literature come true. Monkeys do not spring from tree to tree, throwing coconuts at the delighted passengers, jaguars do not chase tapirs through the forest in full sight of the vessel, and most of the giant saurians nosing along the banks turn out to be drifting logs when the binoculars are turned on them.

Mammalian life is abundant only in the forest far from the river banks. There are found peccaries, tapirs, monkeys of a dozen varieties, small deer, jaguars, and several species of rodents. Even birds are rarely seen along the river banks. An occasional heron, the beautiful but not edible cigana, and, at nightfall, flocks of parrots and paroquets are the only instances of life in motion that the steamer traveler ever sees, if we leave the insects out.

Many insects, however, come aboard at every landing. Besides the gnats and mosquitoes, there is another troublesome flying creature — the "pium" — which is exceedingly active. It alights on its victim, finds a suitable spot, bites, and fills with blood. Then it sails sluggishly away like a small red balloon. A hard point is produced where the insect has bitten. In the center of this swelling is a round point of hemorrhage. The itching

MANAOS

Situated near the confluence of the Rio Negro and the Amazon, this city now has about 25,000 inhabitants. Formerly, during the height of the rubber "boom," Manaos was very active and wealthy, but since the collapse of the rubber industry in the Amazon valley, life seems almost to have left the place

produced is intense, but it does not last long. A score or so of these bites, however, can change an otherwise happy life into one of woe.

These do not by any means exhaust the insect possibilities of the Amazon region, but one must disembark to enjoy the others. The *tucandera*, a large, fierce ant, lives but a few steps away in the forest. Of all insects his bite is the most painful.

A little red fellow called the fire ant, graphically and advisedly from the nature of its bite, brings out the worst in one. Fire ants have been known to invade villages and drive the inhabitants away.

The most interesting of all ants is the *sauba*, called also the umbrella ant. The *sauba* ants march along in bands, carrying bits of leaves, fifteen or twenty times their own size, over their heads like umbrellas. These bits of leaves are carried to the nests where, after being chewed, they form a medium for the growth of a fungus on which the *saubas* live.

As the *saubas* have a special penchant for anything planted, spurning the millions of tons of wild foliage so easy to acquire, they have decided the agricultural problem on the Amazon by making it very nearly impossible for the inhabitants to practice agriculture. These ants may demolish a plantation of banana trees in a single night.

Flying ants drop down on the head of the forest stroller and inject what seems to be sulphuric acid into his ears. He picks a flower and little black ants swarm over his hands. He leans against a tree and a myriad light-brown ants make merry on his neck and explore the region inside his shirt.

The folk who live along the lower Amazon, excepting those who have the clean streets and decent appearing houses of the larger towns to frequent, are a miserable, malaria-racked lot. No one is able to do a really hard day's work. They live mostly in bamboo structures mounted on piles.

Around these dwellings grow the few coffee trees, cacao trees, and plants of manioc which the *sauba* ants have left.

Manioc, or cassava, is the staple food. It is eaten fried and boiled and from it is made that uninteresting food, "farinha." The roots of manioc are washed and peeled. Then they are grated on a utensil made of wood inset with numerous sharp-pointed pebbles. The pulpy product is again washed, and the liquor, which contains a poisonous substance is expressed. The dry pulp is now baked, during which process it disintegrates into hard grains that taste more or less like pieces of cork.

The Amazonian cannot get along without his "farinha." He puts it into soup, when he has any, mixes it with the meat of the turtle, and eats it plain, throwing it with great dexterity from the plate on the table to his mouth with a graceful flip of his spoon.

The inhabitants of the larger towns along the river are not as forlorn as the shack dwellers. Those who live in the cities lead comfortable lives. How most eke out existence is a problem, but they seem always to have enough money to buy white suits. Arrayed in these they sit in comfortable chairs before the bars, watching the Portuguese work, and discussing politics.

Ninety per cent of the conductors and motormen on the Manaos trams are Portuguese. Ninety per cent of the longshoremen, boatmen, and fishermen are of the same race.

Manaos is the pride of the Amazon. Santarem, Obidos, and Itecoatiara, smaller cities on the road from Pará, have well built churches, flower-planted public squares, and little else to excite one. Manaos, however, which lies not on the main stream but nine miles up the Rio Negro, is a substantial modern place.

It was formerly known as Barra, and really found a place on the map when the

THE OPERA AT MANAOS

This million-dollar structure was built at the height of the city's period of prosperity. With the slump in the rubber business, this handsome edifice was closed, and now stands like a silent sentinel watching over the almost lifeless town

SUNSET ON THE ORINOCO RIVER
This scene is near Ciudad Bolivar, about two hundred miles upstream from the river's mouth

capital of the State of Amazonas was moved here from Barcellos in 1807. During the rubber-boom times it progressed amazingly, and in a few years it had developed from a ramshackle sort of frontier town into a place of luxury. About everything needed for a luxurious existence could be found there. A million-dollar theater, which soon closed its doors as the European artists, imported to entertain the inhabitants, died from yellow fever, barber shops reeking of the Orient, perfumery and lotion loges in profusion, ice-cream and candy parlors, scores of bars most gorgeously gotten up in gilt and plate glass, and asphalted streets over which hummed motor cars of the most expensive European makes—this was Manaos.

With the slump in rubber, due to the progress of the Near East plantations, which, ironically enough, had their being in shoots taken from this same Amazon, came bankruptcy to many, but disillusionment to only a few. The bars are closed, the expensive motor cars have disappeared from the streets, but the rubber exporters, those who retain a little credit, still hang on. The rubber collectors, who have no other industry to turn to, still struggle with their product, which today is worth about twenty cents a pound. The Amazonian public was undoubtedly ruined by the prosperity of the boom days. Almost all of the survivors believe that those days will return. The dubious ones moved away long ago.

Manaos, with all its modern buildings, its electricity, its well paved streets, is dead. And the million-dollar theater stands over it like a monument.

It is customary to speak of Manaos as the Jumping-off-place. Travelers to any of the upper reaches of the numerous tributaries of the Amazon are warned that once Manaos is left behind, civilization ceases, comforts are no longer procurable, and that one is up against the stark, stern realities of primitive existence.

It is true that the S. S. "Inca," which

makes a monthly trip up the Negro, has seen better days. Her engines wheeze a bit and her stern paddle wheel hits the water somewhat unevenly. But she is a clean ship, her cabins are roomy, the service aboard is excellent, and the food, for the locality, beyond criticism. A large refrigerating apparatus adds to the comfort of all and, on occasion, to the gaiety of many.

A rather intimate acquaintance with the tributaries of the Amazon, gleaned in more than twenty years of traveling their courses, brings me to the opinion that the Negro is the saddest of them all.

The Morona, Santiago, Tigre, Napo, to name a few of those I know well, never were civilized, never got beyond the stage of thatch-roofed houses situated distant one from another. The Rio Negro, on the other hand, had ambitions. The early Portuguese settlers along its banks counted masons, carpenters, and others artisans among them, and these employed their arts in erecting houses meant to last for centuries. Edifices of brick and stone were built in the most incredibly inaccessible places. When the settlers found that even canoes could not get anywhere near these places during the dry season, they moved. All that remains today of all this wasted effort are a few piles of cut stone lying at different spots along the river's bank, and some weed-covered piles of brick on the outskirts of what today are squalid villages.

The lower four hundred miles of the Negro seems like an enormous lake. The fall is very slight, the river is exceedingly broad, and there are numerous islands. Santa Izabel, five hundred miles from Manaos, is the limit of steam navigation. Just below this place the river changes its character. It becomes narrower, islands are less numerous, and what there are have rock foundations. The current becomes swift. Instead of the interminable forest shown lower down the stream, one sees river banks composed of granite.

Two kerosene motor launches meet the

TRANSPORTATION METHODS ON THE RIO NEGRO

The motor boat has a barge lashed to each side, and thus makes its slow way upstream. Doctor and Mrs. Dickey traveled with this outfit from Santa Izabel to Sao Gabriel—a distance of about 150 miles

RIVER TRAVEL ABOVE SAO GABRIEL
Doctor and Mrs. Dickey with their native canoe-men on the Rio Vaupes, in Brazil, not far from the Colombian border

"Inca" at Santa Izabel, and conduct passengers and freight to Sao Gabriel. As we were ushered aboard a lighter attached to one of these, we saw that "the stark, stern realities of primitive existence" had not, as yet, been reached.

A nice clean cabin with plenty of room for two hammocks, our chairs and tables, welcomed us. A meal composed of fresh turtle soup, fried "piranha"—the fish with the terrible reputation as a man-eater—stewed manioc, cheese with guava jelly, and delicious black coffee didn't seem stark or stern.

Six rapids, all with awe-inspiring reputations, were passed in five days. We heard about them, invariably, some time after we had passed them. Then, on the sixth day, we came to the father of them all, the Rapid of Camanaus. Our launch tried it first with one lighter. After buzzing about a bit without making an inch of headway, we fled ignominiously to shore. Then, with us aboard her, the launch tried it alone. Waves broke over our bow, whirlpools twisted us, but we made it. Then we had to wait while the launch brought load after load from the lighters. The empty lighters were then towed through the rapids by the Indian crew, who swam, carrying the tow rope.

Sao Gabriel is only 225 feet above sea level, and it is hot. A mission there contains more than a hundred sweating Indian boy and girl students, who are able to continue their pursuit of knowledge only by the aid of numerous baths a day. It is no place for a white man to linger long. Luck put us in the way of acquiring a small launch, and hastened our departure.

The launch owner, a relic of the "good times," admitted that the engine of the launch had not been cleaned in nine years. "But," said he, "she hasn't stopped yet."

Six hours above Sao Gabriel the River Vaupes enters the Negro. Along the banks of this river live many tribes of Tokano Indians. They were interesting individuals originally, but the influence

of the missions has caused them to lose most of their arts and primitive customs. The excellent pottery they once made has given place to enameled ware from Hamburg, their picturesque adornments have been supplanted by blue dungarees from Manchester.

However, under proper persuasion of a monetary character, they will doff the habiliments of civilization and don again the feather headdresses and grass tails they used before the padres came. Their lives are spent in little work and much feasting. Feasts are called "casheerees." Little "casheerees" are given in celebration of an extraordinary catch of fish, an especially good crop of "pupunha" nuts, or for no reason at all except to get intoxicated and have a good time. The big "casheerees" are given when some boy attains puberty, in honor of the "Juruparee," or tribal devil, and in celebration of the legendary slaying of "Bucia Wassu," the Great Serpent.

Space prohibits my going into the mattter of these "casheerees" to any great length. I will speak only of the one dedicated to the slaying of the Great Serpent.

Bucia Wassu, according to the legend, came up from the sea, made his headquarters at the Rapids of Ipanoré on the Vaupes, and succeeded in eating all the fish in the region, bringing famine to the Tokanos. The Tokanos, through their "Payay," or medicine man, managed to lure Bucia Wassu ashore by means of a beautiful female serpent (really the medicine man in disguise). The Indians fell upon Bucia Wassu while he was engaged in the pursuit of romance, and slaughtered him.

This, however, did not stop the trouble. Bucia Wassu had made his arrangements before coming ashore, and the Tokanos were astonished one day to see two large serpents, recognizable as a son and a daughter of Bucia Wassu, swimming along near the bank. The offices of the medicine man were again employed. He had

LUNCH WITH A NATIVE AT MALOKA CIGARRO
The Indian is a Tokano, a tribe that inhabits the district near the Vaupes River

"PIPES O' PAN" AMONG THE TOKANOS
The three bedecked Indians are playing their reed pipes for Mrs. Dickey in order to illustrate phases of the dance of "Bucia Wassu"

communication with the serpents and returned with the glad tidings that everything would be all right within a few days, for the female serpent—a beautiful white one—had assured him that at the first opportunity she would kill her brother. The brother, she told the medicine man, wished to follow in his father's footsteps, but she was friendly to the Tokanos and would see that no more fish were destroyed.

Everything turned out as guaranteed by the white serpent, and the incredulous may see proof of this in the deeply chiseled pictures on the rocks at Ipanoré. Among ten sculptured representations of serpents, manatees, and various fish, is one representing Bucia Wassu, traveling the primrose paths, and another of his daughter slaying her brother.

The White Serpent still appears every year to the Tokanos. To our uneducated eyes she seems to be nothing but a long line of white spume which floats down the stream when it is in flood, but the Tokanos know better.

A celebration of the death of Bucia Wassu then, is an excuse for a "casheeree."

With bodies painted in red, with feather headdresses and grass tails waving, with nutshell anklets rattling, the males of the Tokano tribes gather in the interior of the enormous thatch-roofed "maloka," or tribal dwelling place, to drink and dance. Dancing is intermittent and consists of a shuffling back and forth in a circle. Drinking is continuous. The drink is "casheeree," which gives the feast its name. It is made from the fermented juice of the "pupunha" nut, manioc, pineapples, or any other fruit or vegetable at hand. The fermenting medium is usually saliva.

After a high degree of alcoholic saturation is attained, a number of Indians, clasping each other's bodies, writhe like a serpent on the floor, while others attack them with clubs and spears. Thus is Bucia Wassu killed several times a year. Unprintable orgies follow and continue as long as the "casheeree" holds out.

Four days' run from the mouth of the Vaupes brought us to Cuchuy, the last outpost of Brazil. A few hours more brought us to San Carlos, Venezuela.

Now we began to see another class of

Indian—Maquiritaris—folk who have become civilized without benefit of clergy, and are the hardworking standbys of the few rubber collectors left in the region.

The Casiquiari, that remarkable stream which does a right-about and flows from the Orinoco into the Rio Negro (or Guainia as it is called here) joins this river two hours above San Carlos. It is at its mouth a black-water stream. Two days farther up, its waters become muddy, the color of the Amazon, and with this metamorphosis come our old friends the "piums." They are the most persistent, most virulent "piums" one could wish to feel. But leaven is here in the almost incredible numbers of beasts and birds that live their own lives with little to disturb them. For the Casiquiari, never a metropolitan center, has today but four occupied houses along its course of 180 miles, and unmolested otters, in bands of six and more, play about our vessel every day of the trip. Tapirs, each with his proboscis tightly retracted, swim across our bows,

TRADING A BOX OF MATCHES FOR A PAROQUET

These Tokanos have exaggerated their hats almost as if they were trying to offset the limitations of the rest of their costumes

GATHERING CAYMAN EGGS

This "nest" was located at some distance from the river, and its guardian attempted to attack Doctor and Mrs. Dickey, with the resul that it had to be shot. The cayman is a crocodile

and oh! that the tourist people could visit here, for monkeys—little gray ones, big red ones, others with black hoods—really perform acrobatic feats in the trees and refrain from bombarding us with coconuts only because no coconuts are available. Macaws, parrots, and paroquets shriek, and show brief glimpses of gaudy plumage. Egrets skim past and land ungracefully on neighboring sand banks. A dozen varieties of kingfishers, some with the most glorious colorings imaginable, watch us with their beady, staring eyes, as we pass by.

And as there are birds and beasts, there are fish: "tucunaré," "pirahiba," dolphins, even.

The trees grow close to the water's edge on the Casiquiari, and most of them, besides the usual tangle of lianas, seem to bear orchids of the most gorgeous hues. Purple is the predominant color, but there are others—orange, yellow, and white.

Our sputtering, limping, dirty motor had brought us about half way through

PUERTO AYACUCHO
A spot at the lower end of the Maipures Rapids in the Orinoco River

the Casiquiari, at the rate of fewer than twenty miles a day, when we came upon the object of our quest, or as near to it as will ever be possible, I think. For five days we had passed by masses of tangled foliage, with occasional widely separated houses with never a soul in them. Then we came to a collection of ramshackle huts. The place seemed deserted at first, but finally we saw a thin wisp of smoke climbing up through the roof of one of the huts, and presently we heard sounds as of someone in pain. Inside, stretched out in a hammock, was a naked, very light-colored Indian. One of our crew had a smattering of the Guaharibo tongue and was able to communicate with the sick man, who was of that tribe.

He had been captured with six others, he said, by Venezuelan rubber hunters on the Padamo River, and had been brought down the Orinoco, to where the Casiquiari flows out of that stream. He, with his companions, had one night stolen a canoe in which to escape, but had been unable to find paddles. Knowing that any attempt to pole *upstream* back to the Padamo would be a slow process that would result in capture, and that a trip *down* the Orinoco would bring them to the region of civilization which they were anxious to escape, they decided to go down the Casiquiari—the last place pursuers would think of looking for them, as it took them away from home—and make their way back overland to the Padamo—a long, hard journey but a safe one. His companions had carried out this plan, but the sick man had developed malaria and had been compelled to stop here at "Capibara." He said, also, that Whites were no novelty to him as he had been one of the attackers of the Rice Expedition several years ago, although he admitted that he hadn't been able to get as close to them as he was to us.

This man's eyes were dark brown, not black, His hair had a coppery tinge, and his body coloring corresponded to Number 23 on the Broca Chart, which is a Mon-

golian coloring. His eyes were frankly Mongolian in shape.

That was our "white" Indian and interesting enough, in a way, but, some of the things he told us were more interesting still. He told us that his tribe numbered six times ten fingers, that they lived in large, oblong houses surrounded by plantations of sugar cane, manioc, bananas, pineapples, and corn, that many of his tribe were lighter in color than he, and that he had a brother who was as white as a white man! We couldn't shake him in that story. No, his brother was not white like a Brazilian or a Venezuelan, he was as white as we.

Our first reaction was an immediate and insistent resolution to visit the Rio Padamo and bribe, cajole, or otherwise persuade the sick man's brother to accompany us back to the United States. We already envisioned the reception we would receive if we returned accompanied by so remarkable a find. But better counsel prevailed, as it has an awkward way of doing at the potentially thrilling moments and, summing up, we found several insuperable obstacles in our way:

(1) None of our present crew would accompany us to the Padamo.

(2) It would be impossible to get anyone to accompany us, for our arrival among the objects of our search so soon after a raid by rubber hunters on their camp, would undoubtedly cause the Guaharibos to fire on us without going through the formality of examining credentials.

(3) We had just enough fuel to get us to the Orinoco and send the launch back home. So, we didn't go.

Passing out of the Casiquiari, we forsook the launch and proceeded by easy stages and a series of canoes—there was no trouble in getting crews to go *down* stream—to where we found launch navigation again. We passed over two portages on the way. One we passed by ox-cart, the other we crossed quite luxuriously, speeding over its eighty kilometers in a motor car. We had contact with a number of tribes. More Maquiritaris and then the Guahibos—hairy-bodied fellows with chin beards like old-time Kentucky colonels, but, withal, one of the lowest tribes culturally in all South America. They are too indolent to make hammocks, which are so common in this land,

USING THE "BROCA COLOR CHART"
By making use of this chart, accurate records of the skin-color of natives is possible

and they sleep where night overtakes them, in weird contrivances made of green vines which very often dry and break before dawn, thus rendering the breakfast-bell a superfluous article in the Guahibo household. And they have strange tastes, these Guahibos. Not only do they eat any kind of food they are fortunate enough to be able to beg or steal, but, according to the engineer in charge of the construction of the road across the Maipures portage, they go farther than that. Two Guahibos, this man told us, stole ten gallons of motor lubricating oil from the garage and were subsequently found giving a *fête champêtre* to a dozen companions in which the *pièce de résistance* was the motor oil mixed with cassava bread.

The Piarroas, found also in the vicinity of Maipures, are a cleaner lot. They wear about their waists, a hammock-like contrivance of white cotton cloth, which they weave themselves, but that, excepting a remarkably economical burial system, is one of their few distinguishing characteristics. When a Piarroa develops a cold, malaria, or what not, consultations of specialists or medicine men are not held, no drugs are given. The patient is expeditiously bundled off to a cave, where, accompanied by a jar of water and a basket of food, he either gets well and emerges, or dies and remains.

At Ciudad Bolivar our long trip ended after nine months of jungle wandering. It is true that one need not leave all the comforts of civilization in order to reach far interior points of South America, but there are many districts that civilization does not touch. Thus, on our way in, we had finally left the very last traces of civilization behind, and now we were glad, at last, to leave the wilds to the wilds, and to return to the world from which we had come, for the South American jungle, fascinating though it can be, is not perennially attractive to those who enter it.

A TOKANO

Photograph by James P. Chapin, 1921

THE MER DE GLACE, FRANCE

The Mer de Glace is one of four glaciers of Mont Blanc descending into the valley of Chamonix

LIVING GLACIERS

By CHESTER A. REEDS

Curator of Geology and Invertebrate Palæontology, American Museum

GLACIERS afford one of the most magnificent scenic displays to be found on the earth. In our temperate zone they are associated with snow-capped peaks, rugged mountains, fair lakes, and valleys of exquisite beauty.

Glaciers originate in fields of perpetual snow, and creep down valleys as slow-moving rivers of ice to feed high waterfalls, roaring mountain streams, and nestling lakes.

In certain places man has added a touch of picturesqueness to the labors which Nature has so admirably performed. He has climbed the high mountains and laid out roads through the passes. He has established shelters like the Hospice of St. Bernard. He has bored tunnels of astounding length through solid rock, that these glacier fields might be reached more easily, such as the Eismer station near the crest of the Jungfrau in Switzerland. In other places he has established funicular railways from valley to peak, that Nature's wonderland of snow and ice may be viewed more advantageously. In the lower valleys beside charming lakes, and on the great heights beset with clouds, he has placed chalets, toylike villages, and well equipped camps and hotels. Today people go to Switzerland, to Yosemite Valley, to Banff, to Seattle, and to Glacier National Park, to see the wonderful scenery and enjoy the sport and adventure which Nature has provided.

Polar and sub-polar glaciers are not confined wholly to high mountains, for they also cover vast land areas and reach the sea. In such regions, the glaciers and the attending climatic conditions retard the extensive development of railways, and other modern means of travel. It should be recalled, however, that several railroads have been built through the snow and ice fields of Alaska, and one of them, along the Coppermine River, has its road bed laid for five miles upon the terminal margin of the Allen glacier. It is true

that since the advent of the aëroplane and the dirigible balloon, the North Pole and many miles of frozen deserts have been traversed by air ships, but fogs, violent storms, unknown landing places. and the absence of suitable fuel make such attempts at exploration hazardous undertakings unless well organized. The outfitting and the explorations of various polar expeditions, the organization of mountain clubs and ice sports in Europe, America, and New Zealand, have brought glaciers within the realm of popular interest.

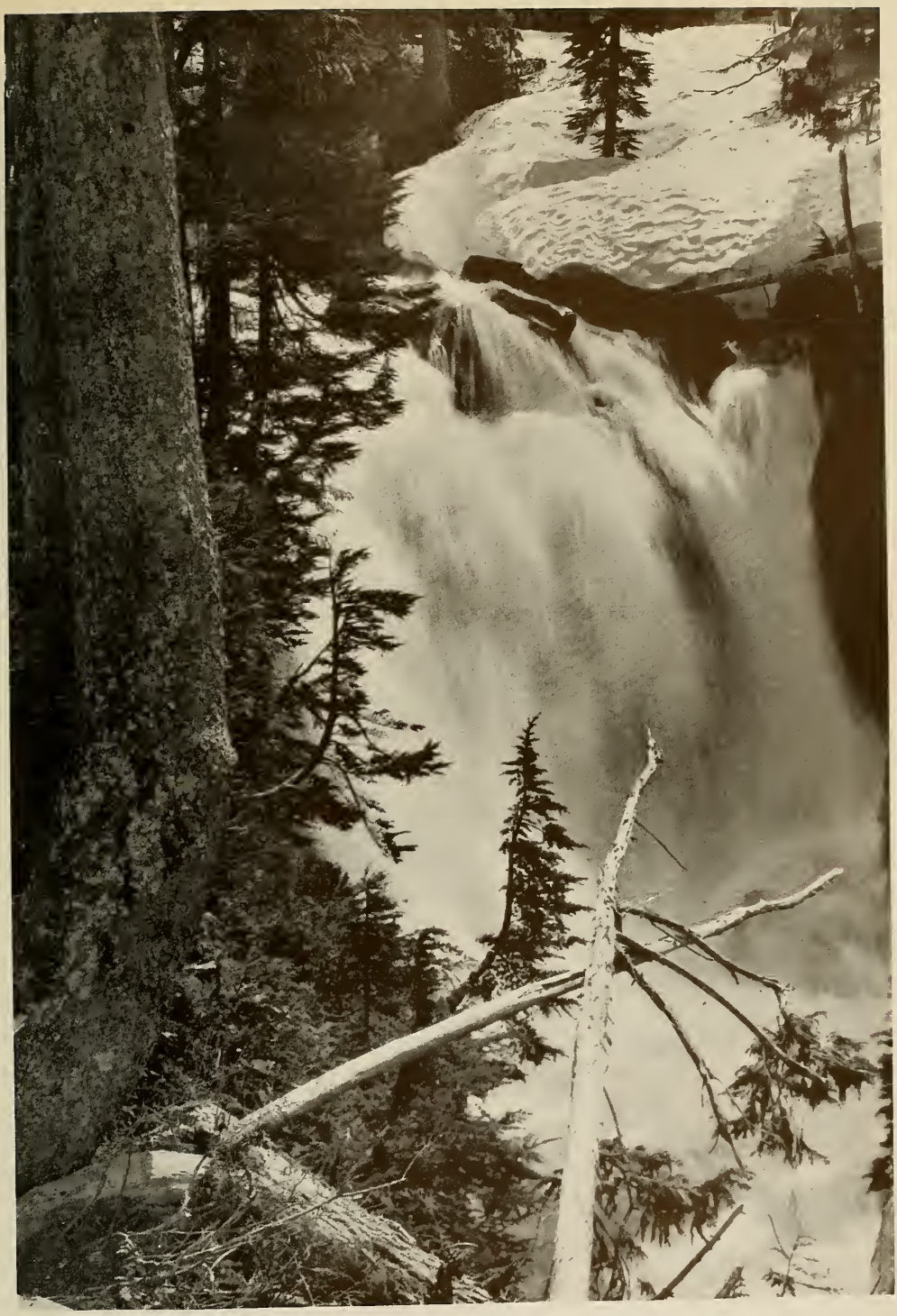
It has not always been so. Up to the end of the Eighteenth Century it was not an uncommon belief that mountain highlands were bewitched. Because of this, the Alps mountains, the modern playground of Europe, were unexplored. It was Horace B. de Saussure (1740–1799), who, with his colleagues, removed the prejudice against the "Montagnes Maudits" and awakened a feeling of enthusiasm for the infinite wonderland of beauty and delight in the higher altitudes of the Alps. Through the example set and the prizes offered by de Saussure, Mont Blanc was first climbed in 1786 by the guide J. Balmat. In succeeding years this and numerous other difficult Alpine peaks were scaled by de Saussure and his exploring parties. He may be regarded as the father of mountain-climbing.

Popular interest in the exploration of the Alps, once having been aroused, has continued down to the present day. In 1837, Louis Agassiz, from his study of the Alpine glaciers and the erratic blocks of rock in the Jura Mountains, anticipated, in a letter to the French Academy, his theory of a former "Ice Age" which he announced more fully in monographic form in 1840 and 1847. These papers, together with that of Jean de Charpentier in 1841, created a deep interest in glaciers, not so much because of the Alpine glaciers themselves, but because for the first time it afforded a satisfactory explanation of the erratic bowlders, which are found strewn over the Alpine foreland, the north German plain, the Scandinavian peninsula, the British Isles, Canada, the northern United States, and many other parts of the world. This was a brilliant generalization.

Subsequent studies by individual geologists and governmental organizations in many lands have confirmed the theory that there was not only an extensive Ice Age in comparatively recent times, but evidence in the rocks points to the development of other glacial periods at widely separated intervals in geologic time. Recent studies in the Alps, particularly those of Penk and Brückner in 1901–1909, have revealed that the last Ice Age was not a single cold period, but that it was a multiple affair, with four periods of glaciation known as the Günz, Mindel, Riss, and Würm stages, separated by long interglacial periods. The numerous lakes of Canada, Maine, New York, Michigan, Wisconsin, Minnesota, Argentina, Finland, Sweden, and Switzerland, were developed by these great moving masses of ice, and hence are of glacial origin.

Present-day glaciers are formed on those portions of the earth's surface that are permanently above the snow-line. This line varies locally, even in the same latitude, being in some places higher than in others, but generally speaking, it is of the nature of an elliptical surface surrounding the earth with its longest diameter in the equatorial belt, and its shortest in the polar regions, where it touches sea level. From the Arctic to the Antarctic circles this cold surface rises upward in a broad dome 16,000 to 18,000 feet high over the tropics, and cuts a number of lofty peaks and mountain ranges whose upper levels receive all their moisture in the form of snow.

Glaciers consequently have a wide distribution. They occur in Greenland,



THE TERMINUS OF A GLACIER ON THE SLOPES OF MOUNT RANIER

Twenty-four glaciers appear about the snow-capped peak of Mount Ranier in the state of Washington. As these ice masses move down the mountain-sides to elevations 4500 and 5500 feet above the sea, their terminii melt to form the sources of numerous mountain streams. Here various species of evergreen trees of large size grow in close proximity to the ice front

Photograph by Rollo H. Beck

A GLACIER OF TIERRA DEL FUEGO ENTERING THE BEAGLE CHANNEL, CHILE

The highest elevations in Tierra del Fuego are the snow-capped peaks of Mount Darwin and Mount Sarmiento (7200 feet), which contain glaciers of greater extent than Mont Blanc of the French Alps. Glaciers are very abundant in Tierra del Fuego, with a snow-line varying in height from 4900 feet to 1600 feet. Beagle Channel, an east-west passage at 55° S. latitude, was named after the "Beagle," the ship in which Charles Darwin made his memorable voyage through these waters in 1832

which is covered with an entire sheet of ice, except for the marginal ribbon of land, which is usually from five to twenty-five miles in width with a few places where the edge of the ice is sixty to one hundred miles from the shore. Ice caps and valley glaciers are found in Baffin Land, Ellesmere Land, and a few of the islands to the westward, in Iceland, Norway, Sweden, Spitzbergen, Franz Joseph Land, and Novaya Zemlya. Glaciers of the Alpine or valley type occur in the Old World in the Alps, Pyrenees, Caucasus, Himalayas, Tian Shan and East Sayan mountains of Central Asia, and the high peaks on the equator in east central Africa.

In North and South America glaciers occur in the high mountain ranges facing the Pacific Ocean. They are most fully developed in Alaska, and in Chile and Argentina, where they face moisture-laden westerly winds. In New Zealand numerous lakes, waterfalls and glaciers, one eighteen miles long, are to be found in the south island. In the south polar region, the Antarctic continent is not only covered with a great ice cap, but it affords the largest glaciers in the world.

While the facilities and accommodations for seeing the 1155 glaciers of the Alps are unsurpassed, it should be noted that most of the glaciers are small, some of them being only a few hundred yards in length. The largest of these is the Aletsch, which is ten miles long, and with its snow field, fifteen miles. It is about a mile wide, and terminates about 4000 feet below the snow-line, which is at an elevation of 8500 feet. The average length of the better-known glaciers of the Alps is from three to five miles, but the greater number of them are less than a mile in length and considerably less than a mile in width. Little is known as to their

thickness, but it is estimated that they attain a depth of from 800 to 1200 feet. As to the rate of motion there is a considerable difference. The smaller ones may be quiescent, while the larger ones move at the rate of several feet a day. The Mer de Glace, one of the largest, was observed in 1912 to have a daily rate of 18 inches near the sides, much less at the margins, and about 27 inches in the central axial portion.

Large and small valley glaciers of the Alpine type are also found in the Caucasus mountains where the snow-line appears at 8500 feet at the western and 14,000 feet at the eastern end. Numerous large valley glaciers occur in south central Asia, in the Himalayas, and the Tian Shan Mountains, with a snow-line at 16,000 feet at the south and several thousand feet higher along the northern margins. In the Himalayas the Siachen or Rose glacier, which is 45 miles long and 2½ to 2¾ miles wide, is the longest glacier in Asia and is comparable in length with the large glaciers of Alaska. In the Tian Shan Mountains the largest glacier is the Imylchek, which is reported to be 40½ miles long and 1¼ to 2¼ miles wide.

The glaciers of Alaska are the largest in the world except those in the polar regions. The broad sustained mountain range bears thousands of them; a few hundred have received names; some have

THE FRONT OF TUMBLING GLACIER, MOUNT ROBSON, BRITISH COLUMBIA

About ten miles north of the Grand Trunk Pacific Railway there is a climax of snow and ice centering around Mount Robson (13,068 feet), the highest summit of the main range of the Canadian Cordillera. The mountain is clad with snow and ice, and mighty glaciers fall from great heights on every side. On the north, Tumbling Glacier falls more than 5000 feet to Berg Lake to bury its nose in the waters of this beautiful tarn. Great blocks of ice, which break off frequently with reports like thunder, fall into the lake to produce waterspouts and minature icebergs

Photograph by H. E. Anthony

A DISTANT VIEW OF THE SNOW-LINE ON MOUNT COTOPAXI, ECUADOR

In Ecuador the active volcano Cotopaxi (19,613 feet), which is less than one degree south of the equator, is not only snow-capped, but it supports glaciers. It is one of 22 high peaks almost in sight of one another, which rise along the eastern and western margins of the Andean Cordillera in Ecuador. Their conical summits culminate far above the line of perpetual snow which, in this region, is about 15,750 feet above the sea

been partly mapped, but many have never been seen. Beginning near the 63d parallel, they increase in size and depth until the lofty region between Mount Fairweather and Mount St. Elias is reached, where a considerable number discharge into the waters of the ocean. Between latitude 56° and 60° there are probably five thousand glaciers, hundreds of large size descending through the forests, with more than twenty-five discharging into the sea. Icebergs are given off from them, but due to the intricate labyrinth of channels and high-walled fiords, few of them reach the open ocean before melting.

Through British Columbia, the broad mountain chain is generally glacier-bearing. The upper branches of nearly every one of the main cañons are occupied by glaciers, which gradually diminish in size southward. In Washington and Oregon groups of active glaciers still exist on all of the highest mountains, particularly on Mounts Jefferson, Adams, Saint Helens, Hood, Rainier, and Baker. Of these, Mount Rainier is the highest and iciest. Twenty-four glaciers from seven to fifteen miles long radiate from its snow-covered cap to form the sources of the principal streams. One of these rivers, arising from the snout of the longest glacier at an elevation of 4500 feet, pours a stream opaque with glacial mud into the head of Puget Sound.

In California there are about sixty-five small residual glaciers in the Sierra Nevada Mountains, between latitudes 36° 30′ and 39° distributed singly or in small groups on the north sides of the highest peaks at an elevation of about 11,000 to 12,000 feet above the level of the sea—all remnants of the grand glaciers that once covered the range. Between latitudes 37° and 38° they form the highest sources of the San Joaquin,

Toulome, Merced, and Owens rivers. Mount Shasta, near the northern boundary of California, has five shrinking glacier remnants, the largest about three miles in length.

In central Mexico near latitude 19° there are three high extinct volcanic peaks, namely: Orizaba, 18,209 feet, Popocatapetl 17,888 feet, and Ixtaccihuatl, 17,343 feet, which are snow clad, with the snow-line appearing at about 15,000 feet.

In South America there are many glaciers in the Andes even beneath the Equator itself; and though these glaciers are small and mostly confined to the highest peaks, toward their southern end along Smyth Channel and in the Strait of Magellan they are large and flow far down the slopes, and at several places enter the sea.

The snow-line of the Andes is highest in parts of Peru and Bolivia, where it lies at about 17,500 feet. Its general elevation from the extreme north to Patagonia is 14,500 to 16,500 feet, but along the Patagonian frontier it sinks rapidly, being 5000 feet in central Chile, 2300 in southern Chile, and 1600 in Tierra del Fuego. The snow-line is generally about 2500 feet lower on the east than on the west side of the mountains except in southern Chili where it is lower on the west side.

In Antarctica snow and ice cover the land so completely, and to such great thickness, that it has been impossible to determine whether it is one great continent or a series of islands covered with great glaciers. In numerous places glacier tongues and shelf-ice appear about the margin of the continent. Furthermore, a zone of pack ice about ten degrees in

Photograph by H. E. Anthony, 1923

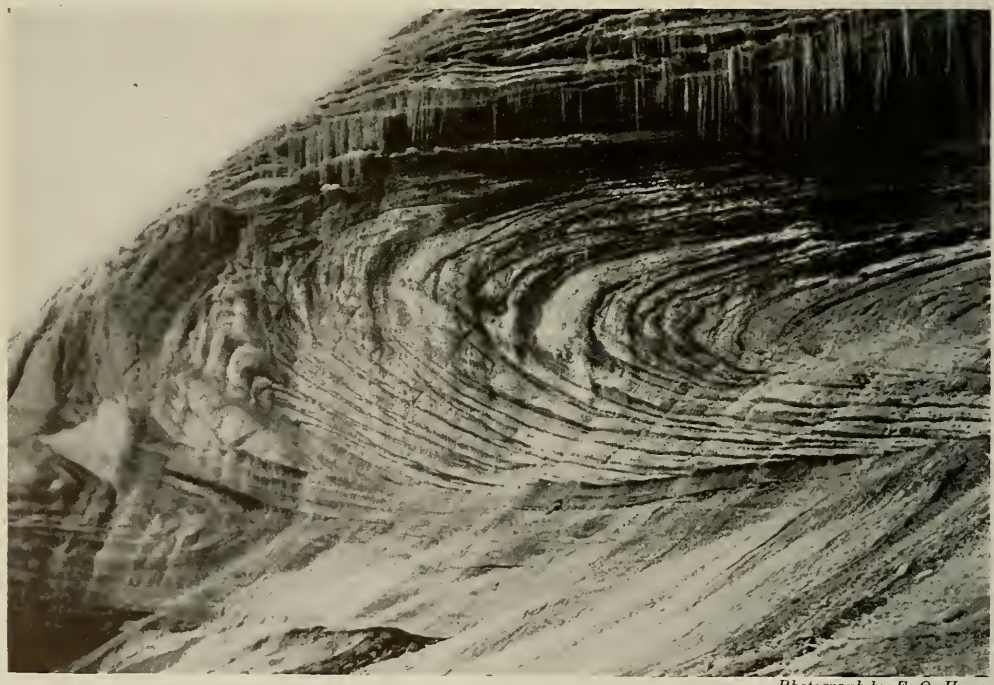
A TROPICAL GLACIER ON THE SLOPES OF ANTISANA, ECUADOR

Mount Antisana, like Cotopaxi, is one of the high peaks of the eastern range of the Andes in Ecuador. It is less than half a degree south of the equator, and has an elevation of 19,335 feet above the sea with a snow-line at approximately 15,750 feet. All of the higher summits of Ecuador have true glaciers. The largest glaciers are found on Antisana, and Cayambe (19,186 feet), which has twelve, and Chimborazo (20,498 feet) the highest mountain of the western range, which has eleven

Photograph by W. E. Ekblaw

UMANAK GLACIER, NORTH STAR BAY, GREENLAND

The seasonal deposition of snow on the Greenland ice-cap is apparent from the horizontally banded lines of stratification shown in this view



Photograph by E. O. Hovey

THE GREENLAND ICE-CAP IN PARKER SNOW BAY

Horizontally disposed layers of snow and ice may become distorted as shown by the overriding of one ice mass on another

Photograph by D. B. Macmillan

THE ESKIMO VILLAGE OF PETERAVIK AND CLEMENT MARKHAM GLACIER

The Clement Markham glacier is one of the outlets of the Greenland ice-cap, which passes alongside the black-striped Cape Chalon to Smith Sound

Photograph by D. B. Macmillan

FRONT OF BROTHER JOHN'S GLACIER, FOULKE FIORD, GREENLAND

Brother John's glacier, named by Doctor Kane in 1855 after his brother John, dips into Alida Lake at the eastern end of the Foulke Fiord. Note dark terminal moraine at base

TWIN GLACIERS OF THE TAKU INLET, ALASKA

Taku Inlet is a beautiful fiord just south of Juneau, the capital of Alaska. It is visited by thousands of tourists every year. Taku glacier, which is 30 miles long, heads to the north on a 5500-foot snow divide. It receives some ten tributaries from ½ to 1½ miles wide, the main glacier being 2 to 3 miles wide. It gives off two distributaries, one of which feeds the west half of the Twin Glaciers of Taku Inlet. Other glaciers which enter the fiord are the Morris, and the Wright, and numerous small glaciers up the Taku River

width, which encircles the continent, offers a serious obstruction to those who would approach it. It is a large continent with margins coinciding roughly with the Antarctic circle, and having an estimated area varying from 3,000,000 to 5,000,000 square miles. So little land is exposed that solar radiation has no effect upon the snow and ice masses during the long dark winters, and but little during the summer months. The average temperature at widely separated points on the margin of the continent is 29° F. during the summer and −35° F. during the winter, with maximums of −45° F. There is no melting and probably no other form of precipitation than that of snow, which has been estimated to be from seven to ten inches annually. It is difficult, however, to take such observations, owing to the drifting of loose snow by the wind. Mawson has aptly styled it "'The Home of the Blizzard."

The depth of the inland ice is unknown, but it may well be thousands of feet thick. Amundsen and Scott, after crossing the level ice of the Great Ice Barrier, climbed up from 1000 to 8000 feet over huge glaciers, between mountain peaks approximating 11,300 feet high, to an ice-covered plateau the greatest elevation of which was 9860 feet. The elevation at the South Pole as noted by Scott was 9070 feet.

The numerous glacier outlets from this ice plateau to the Great Ice Barrier below vary as to size. Through one of them passes the Beardmore Glacier, which is more than 125 miles long and from 10 to 20 miles wide, with a total area of at least 5000 square miles. This is the largest valley glacier that has been recorded anywhere.

The Great Ice Barrier is different from these glaciers in many ways. Various

explorers have shown that it is afloat for at least 400 miles from east to west along its outer margin on the Ross Sea. It exposes a seaward cliff from 50 to 280 feet above the water, and forms a vast plain of ice extending southward about 400 miles, along the foot of the high mountains bordering South Victoria Land. The numerous glaciers, which move down from this high land to the Barrier, cause the ice of the Barrier to move forward toward the Ross Sea at the rate of 1500 feet per year. The structure of the marginal face of the Great Ice Barrier shows that it is not a true glacier, but that it is composed primarily of thick layers of snow horizontally stratified. An indentation of the Ross Sea near the easterly end of the Great Ice Barrier, known as the Bay of Wales, is the place from which Commander Richard E. Byrd and Sir George Wilkins have proposed to conduct their forthcoming respective aëroplane exploration flights in the Ross quadrant of the Antarctic continent.

It may be seen from the foregoing discussion that glaciers are at home in either high latitudes or high elevations. Where the snowfall is in excess of melting and evaporation, a blanket of snow remains the year round. The lower limit of this snow constitutes the snow-line, while the snow-covered area above is known as the snow field. Where the snow accumulates to considerable thicknesses, or where it stands for months, it is transformed into a granular stage called névé, and at lower levels into ice. The névé stage is intermediate in position between freshly fallen snow and the ice of a glacier. The exact process by which the transformation takes place is not yet demonstrated, but it is apparently a molecular rearrangement in which snowflakes join together to form

TERMINUS OF THE TAKU GLACIER, TAKU INLET, ALASKA

Taku glacier discharges icebergs into Taku Inlet. Its sea front is more than a mile wide and 200 feet high. A maze of seracs and crevasses appear on the surface of the glacier, while at the front, two dark patches near the water's edge show where englacial streams emerge from the depths of the ice mass. Taku glacier is one of the numerous tidal glaciers found in Alaska. The depth of the submerged ice-front is not known, but it is supposed that it is several hundred feet

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THE MONTE ROSA GLACIER, SWITZERLAND

About nine miles southeast of Zermatt, Switzerland, appear the high serrated peaks of Monte Rosa, 15,217 feet above the sea. From this elevation about fifteen glaciers move down the mountain-sides in various directions. From the highest crests the Monte Rosa glacier descends in a northwesterly direction for three miles toward Zermatt. About the margin and within the path of this glacier, various rock masses projecting above the surface of the ice stream constitute the source of the bowlders and other material displayed so conspicuously in the lateral and median moraines shown here

larger crystals, névé, and solid ice. In going the length of a glacier, one also encounters these three stages, to wit: in the higher levels the *snow field*, at a lower level the granular ice or *névé*, and for the remaining levels down to the terminus, or snout, the *ice stream*.

The exact thickness required for the beginning of ice-flowage is unknown, and it doubtless varies with the temperature of the ice and the slope on which it rests. In all probability a depth of several hundred feet of snow is required, perhaps more in Arctic regions where the cold delays the transformation of snow, first into névé, and then into ice. It is believed that the flowage of the ice in the lower portion of a snow field is a direct result of the pressure of the superincumbent load. Ice, like rock, is brittle under ordinary atmospheric pressures and is easily broken, but under the pressure of several hundred feet of snow and névé, strains and stresses no longer cause rupture, but give rise to flowage. Accordingly, a large mass of ice consists of an upper zone of fracture and a lower zone of flowage, as in the rocks of the earth's crust. The size of a glacier varies with the extent of the contributing snow field. It may be small and short, or it may be many miles long, and many miles broad, according to the snow supply.

The small glaciers may terminate only slightly below the snow-line, but the larger ones may descend thousands of feet below it. The majority of valley glaciers terminate on land, a few in lakes, and some of the large ones, in polar or subpolar regions, reach the sea and discharge icebergs. Glaciers terminating in the sea

like Muir, Taku, Hubbard, and Columbia in Alaska, and the Clement Markham and Umanak in Greenland, are called *tidal* glaciers. They present fronts from 900 to 1000 feet both above and below sea level. The Humbolt Glacier in Greenland enters the sea along a front 60 miles wide, but many other tidal glaciers are only 5 miles wide.

Four main types of glaciers have been recognized, namely:

(1) Valley glaciers, which are confined to valleys. In this connection it should be noted that a small valley glacier occurring high in the mountains is sometimes referred to as a *cliff* glacier, owing to its high back wall of rock, or as a *cirque*, since it occupies a basin like an amphitheater.

(2) Piedmont glaciers, which represent bulbous accumulations or the union of two or more valley glaciers on a plateau at the foot of a mountain, such as the Malaspina glacier in Alaska.

(3) Ice caps, which represent those larger ice accumulations where the movement is outward in all directions from the center. Ice caps are normally thickest at their centers and thinner at the edges. They are typically developed only in polar or subpolar regions.

(4) Continental glaciers, or large ice caps, which exist in Greenland and Antarctica. In those lands it is estimated that the ice caps are more than 5000 feet thick at their centers, the ice moving outward in all directions.

Rows of stakes or stones placed in line across a glacier are found to change their position with respect to objects on the bank, and also with regard to each other.

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THE GRAND MULETS AND MONT BLANC

Mont Blanc (15,782 feet) is the highest of European mountains. Since 1860 it has formed the boundary between France and Italy, and although composed chiefly of granite, it is shrouded with a thick mantle of snow. The crest of the mountain is six miles south of Chamonix, while the Grand Mulets (10,030 feet) are four miles. Numerous glaciers emanate from the snow-capped Mont Blanc. The most famous of these is the glacier des Bossons, for the trail to the Mulets and Mont Blanc traverses it. Yawning crevasses are present here as on other glaciers

Photograph by W. J. Morden, 1926

GLACIERS IN THE TIAN SHAN MOUNTAINS OF CENTRAL ASIA

View taken near Kain-ya-lak, Chinese Turkestan, just north of the Musart Pass (12,125 feet). During the glacial period many large glaciers 30–50 miles in length were developed in the Tian Shan mountains, but at present the glaciers are of comparatively small size, and resemble closely those of the Alps mountains. The living glaciers rarely descend below a height of 12,000 feet

The stakes in the center of the ice-stream gradually move away from those at the side, proving that the center moves faster than the sides. It has also been shown that the surface portions move more rapidly than the deeper layers where the friction is greatest.

The surfaces of glaciers oftentimes present yawning fissures known as crevasses. They are developed wherever there is appreciable tension or straining of the ice. They may be produced by an abrupt change in the gradient of the glacier bed, or by the more rapid movement of one portion of a glacier with respect to an adjacent portion, or by thrusting or overriding of one ice mass on another. Crevasses may appear anywhere throughout the length of a glacier. Above the snow-line they are particularly dangerous, since the snow often partly or completely conceals them, and the unway mountaineer who has not tested his snow bridges is apt to disappear suddenly into a yawning chasm 200 or 300 feet deep.

In the lower extremity of ag lacier where evidences of surface melting are more pronounced, mazes of ice ridges, pinnacles, seracs, and crevasses may appear, especially where differential motion or ice falls are manifest. As the ice melts, tiny streamlets of water may find escape through a hole in the ice, known as a *moulin*. The water that finds its way into such openings may cascade to the bottom of the glacier or it may escape through a channel in the ice to the front of the glacier to form englacial or subglacial streams. Large ice caves in glaciers are frequently formed in this manner and may be entered at certain seasons, particularly during the winter, when there is little melting.

In the upper reaches of a glacier the surface is apt to be free of rock débris

but in the middle and lower courses it may be otherwise. The débris is sometimes disposed in the form of belts or *moraines*, and it is not uncommon in regions where tributary glaciers flow into a main ice stream to have *lateral* and *median* moraines or, if the glacial field is complex, to have a series of them occupying various intermediate positions on the ice. The rock material constituting these moraines is derived from the valley walls, where it may be loosened by weathering and cascaded down in snow avalanches or scoured and plucked from the sides and bottom of the glacier bed by the ice itself. In moving forward, glaciers develop frontal or *terminal* moraines as well as *ground* moraines. Ice is a powerful agent of erosion, but when it takes the form of glaciers it is even more powerful; it widens valleys, it deepens lakes, and scrapes away the soil from vast areas to form its various morainal deposits. On retreating, it leaves in certain places scratched and polished surfaces of bare rock; in others, great sheets of unsorted material. This, however, is another story.

In concluding this article it may be said that living glaciers are not only beautiful to behold, but they are powerful. Their solemn splendor is so fascinating that thousands of people visit the more accessible ones every year. Their extent and work are small as compared with that of their giant forebears of the Glacial Period, yet they are of special interest to us, for they give us a clue as to what the climatic conditions and vicissitudes were in those eventful times when palæolithic man had to clothe his body with furs and make his home with wild beasts in the not too comfortable limestone caverns of southern France and northern Spain.

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THE CREVASSED SURFACE OF THE RHONE GLACIER, SWITZERLAND

The Rhone glacier which is about six miles long, affords many admirable views of its fantastic ice masses. The glacier descends in a series of terraces from about 11,400 feet to 5,750 feet, where it gives rise to the Rhone River. In the foreground of the picture many yawning crevasses are in evidence

A section of the painted and sculptured frieze from the Temple of the Tigers at Chichen Itza, Yucatan, showing Toltec warriors. From a cast in the Museum of the University of Pennsylvania

THE EGYPT OF AMERICA

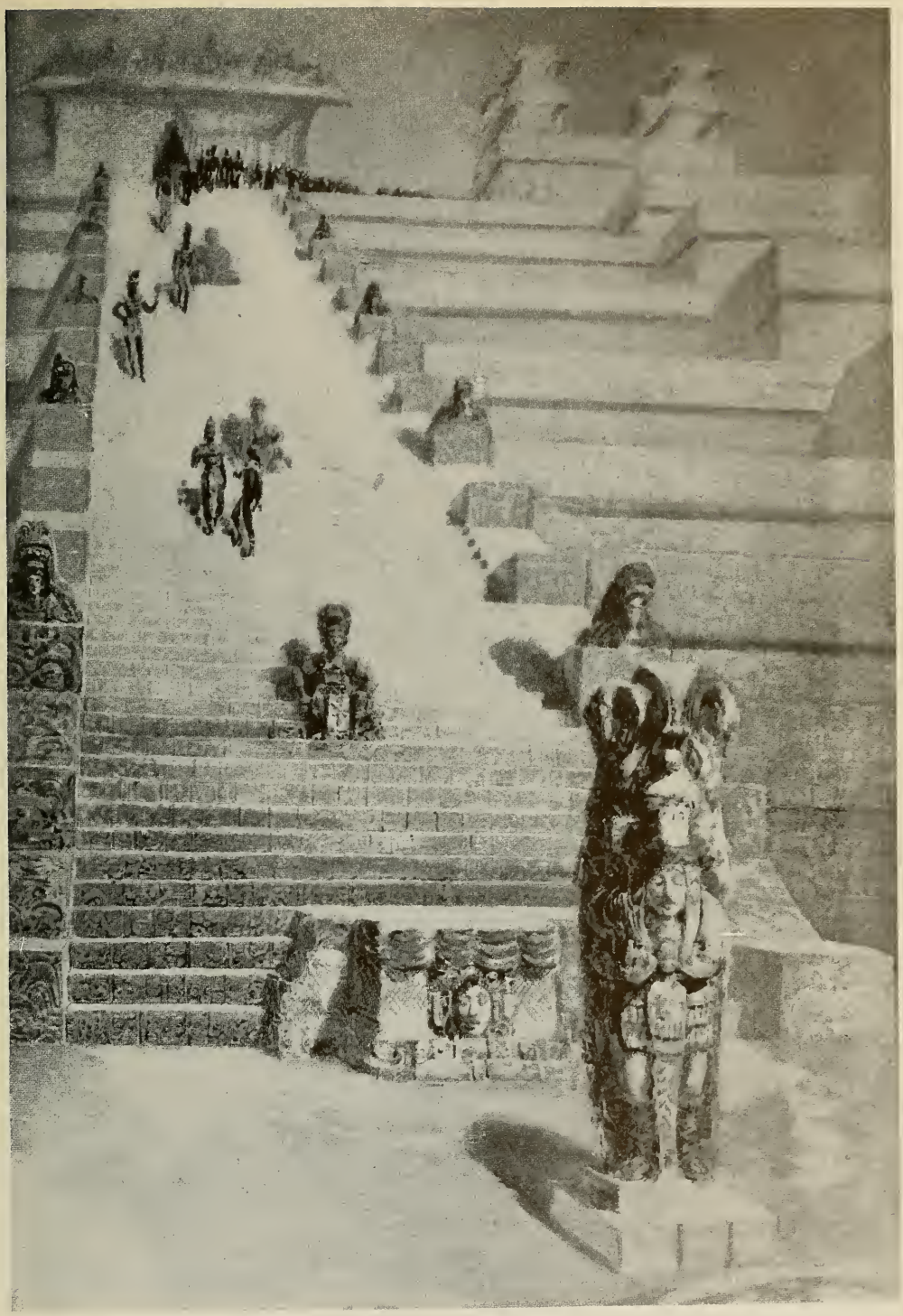
A Short Outline of the Maya, Who Developed the Outstanding Aboriginal American Civilization, and Left Sculptured Monuments that Record Their History Since Before the Dawn of the Christian Era

By J. ALDEN MASON
Curator of American Section, University Museum, University of Pennsylvania

THE land of the Maya nation in Guatemala and the surrounding countries of Yucatan, southern Mexico, Salvador, and northern Honduras, has frequently been termed the "Egypt of America." Trite as the term is, it becomes daily more and more appropriate. First employed because of the superficial resemblance of Mayan archæology to that of Egypt, the term receives especial sanction now that the Maya culture is recognized as probably the oldest of the higher civilizations of America, that it was the fountain-head from which many elements of culture spread to the surrounding nations, and that its dated monuments may be employed as the time scale by which other American cultural phenomena can be dated.

Taking into account their background and environment, we may say that the Maya made as great an achievement as any of the great nations of antiquity. Their tropical climate is, and probably always was, enervating and debilitating, and one which made agriculture a ceaseless struggle against the encroaching jungle. Yet here they developed one of the outstanding civilizations of the world, without any contact, so far as has been proved, with the Old World.

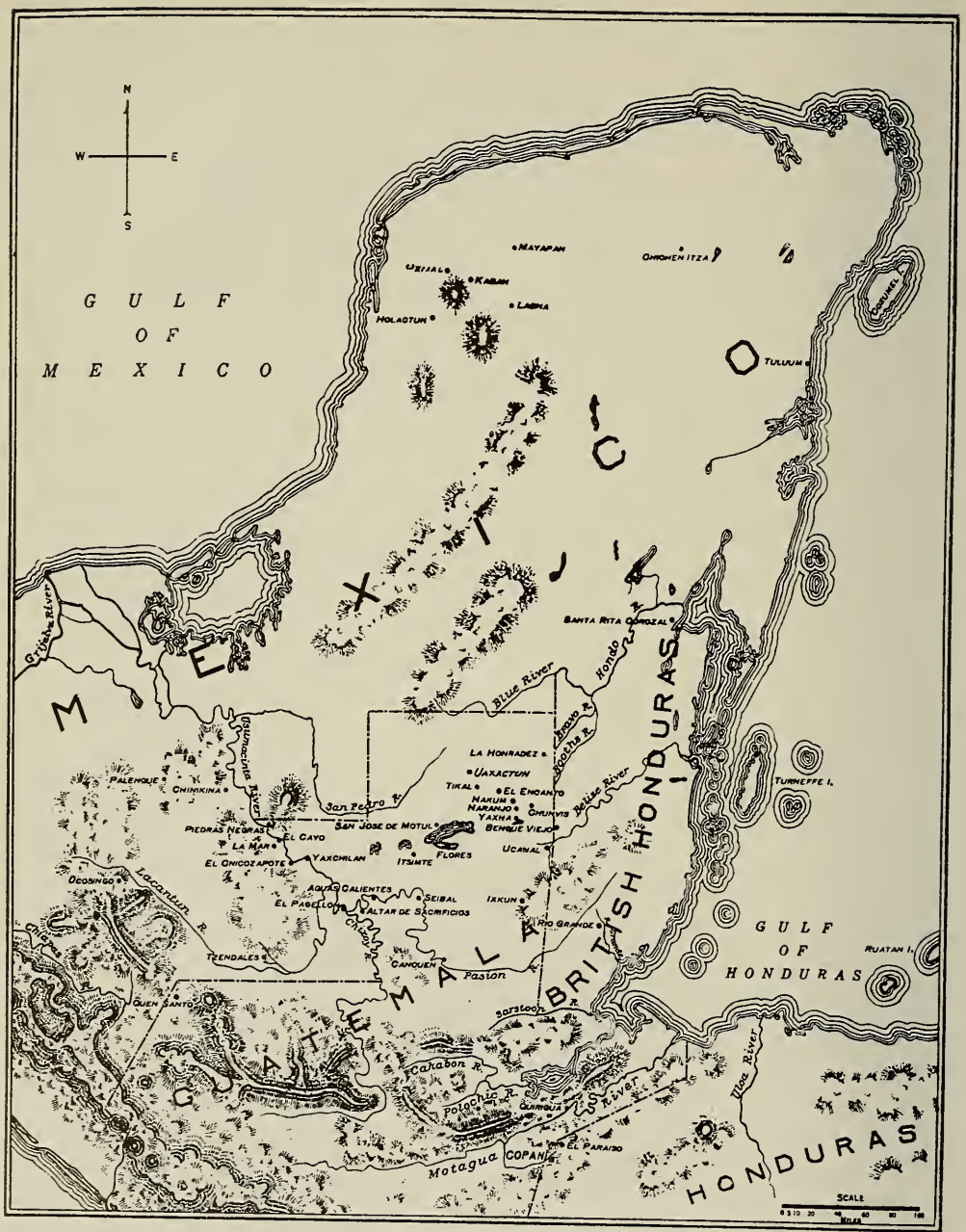
The Maya were the only people in America who had invented a system of writing and who were able to make exact records. This system of hieroglyphic writing is universally acknowledged as the foremost intellectual achievement of ancient America. Although up to the present time less than half of the known glyphs have been deciphered, they give us the skeleton of Maya chronology, since almost all of those so far interpreted are calendrical, astronomical, and mathematical, and refer to definite dates. A few symbols for the cardinal directions and for the colors pertaining to them, some figures of gods, and a few naturalistic objects conclude the sum of the deciphered glyphs. The undeciphered half of the total number of glyphs may record the



THE HIEROGLYPHIC STAIRWAY AT COPAN

(Reconstructed by Dr. G. B. Gordon and Henry Sandham)

An imaginative reconstruction of the famous hieroglyphic stairway on the western side of Mound 26 of the Acropolis at Copan. In this stairway was contained one of the longest Mayan inscriptions known, consisting of about 2500 separate glyphs, only a third of which have been preserved in their original order. Of the original stairway there now remain two sections of fifteen consecutive steps each, and two other sections of undetermined length



THE HOME OF THE MAYA

Map of the region occupied by the Maya civilization, showing location of the principal cities having inscriptions. From *The Inscriptions at Copan*, by S. G. Morley

historical events which took place upon these dates. These hieroglyphs are, in the main, conventionalized pictures and symbols, pictographic and ideographic, but with traces of phoneticism; they are not alphabetic.

The origin of this hieroglyphic system is lost in the mists of antiquity; no tradi-

tion records the name of the originator nor the details concerning the invention. Although the oldest known date records only 96 B.C., the well-developed character of the symbols indicates that they must have undergone a long period of development, and their cursive and curvilinear nature indicates that they were drawn upon a smooth surface long before the art of sculpture developed sufficiently to permit of their being carved upon enduring stone.

In addition to these permanent hieroglyphic inscriptions carved upon stone, the later Maya possessed many books written with these same characters. Unlike the relatively imperishable monuments, these works, in which were recorded all the knowledge of the Maya and which existed in quantities at that time, perished as a sacrifice to the bigotry of the Spanish priests. Bishop Landa wrote, "I collected four thousand of their iniquitous books and images and burnt them on the public square of Tikal, much to the lamentations of the natives." The native could hardly bemoan this holocaust more bitterly than does the student of today, for only three of these priceless books, all now in libraries in Europe, escaped the searching eye and the brand of the friars. These three surviving codices apparently deal with astronomical and mathematical tables and probably were primarily concerned with magical formulæ. The fact that this lore and wisdom were confined to the priestly class was no doubt the cause of the practically complete eradication of all Maya science and wisdom at the time of the Conquest, for the native priests were, of course, but arch-devils in the eyes of the Spanish priesthood, and probably few of them survived by many days the conquest of their villages.

Before reviewing the history of the Maya, let us briefly consider their calendrical system and the astronomical observations and mathematical calculations upon which it was based, for no feat of any people of equal background has

EL CASTILLO AT CHICHEN ITZA, YUCATAN—A VIEW LOOKING SOUTHEAST
Important buildings in Yucatan are usually built on raised foundations ranging from low mounds to high structures pyramidal in form. Ordinarily these pyramids are stepped, with sloping risers

THE GREAT TURTLE AT QUIRIGUA

Animal altars of this type are known only from Copan and Quirigua. If the faces on the tops of altars from Quirigua were arranged in definite sequence, they would demonstrate a development from the simple to the complex in the art of that city. Although known as the Great Turtle, this sculpture has also been designated as a form of what is known as the Two-headed Dragon in Maya art

ever surpassed it. It ranks, with the hieroglyphic system which records it, as the greatest intellectual achievement of aboriginal America.

All calendrical systems must be based upon an exact determination of the length of the year, a difficult feat for nations without precise astronomical instruments. The year, as we know, cannot be divided into an exact number of days or of months, consisting as it does of 365.2422 days and 12.37 lunations of 29.53 days each. These fractions have ever been the stumbling block of calendographers. The Julian year which was in use in southern Europe until 1532, in northern Europe until 1700, and in Russia until a few years ago, was twelve minutes too long, so that at the time of the Russian adoption of the Gregorian calendar, it was wrong by nearly two weeks. The Maya, two thousand years before that, without accurate astronomical instruments, had calculated the length of the year to within one day in 2148 years. Our present calendar is little more accurate, being correct to within one day in 3323 years. The lunar period had been calculated with almost equal accuracy with an error of only one day in 300 years.

In addition to this, the Maya determined with great accuracy the periods of the revolutions of Venus, probably of Mars, and possibly even of Jupiter, Saturn, and Mercury. The Venus calendar was frequently employed, and they were aware, for instance, that 8 solar years almost exactly equal 5 Venus years, and 65 Venus years 104 solar years, or two of their calendar rounds. The solar, lunar, and Venus calendars were combined in permutations so that incredibly long periods of time were calculated. Calculations up to 34,156 years have been found. Eclipse periods were predicted, and very abstruse

A SOMEWHAT IDEALISTIC DRAWING OF A STUCCO BAS RELIEF AT PALENQUE, KNOWN AS THE "BEAU RELIEF"

AN INTERIOR VIEW OF THE BALL COURT, CHICHEN ITZA, YUCATAN
Showing the side wall with a stone ring in place, the goal for the ball. A small, well preserved temple rests on top of the wall

mathematical calculations made. These calculations were based mainly on accurate and long-continued observations on the solstices, equinoxes, and on two points in the agricultural year, April 9 and September 2.

The recording of the mathematical tables depended upon the realization and required the invention of a symbol for the concept of zero. This is another of the Maya's claims to fame. The symbol zero is so matter-of-fact to us that we fail to realize the unusual character of the sign, a symbol for nothing. Yet without such a symbol, rapid mathematical calculations are impossible. It is the zero symbol which makes place-value numeration possible. Nevertheless, it was not until between the Sixth and Seventh Centuries that our symbol for zero was invented in India, from whence it spread to Europe several centuries later. The Maya, the only other people in the world to invent such a concept, anticipated the Hindu inventor by a thousand years.

With these few notes on Mayan intellectual achievements, let us turn to the much more interesting topic of Maya history.

First of all, let me say that the American archæologist recognizes no relationship between the Maya and any people of the Old World. The extreme difference in physical type, language, and the fundamentals of culture is enough far to outweigh any superficial resemblances. The Maya were and are, by blood and language, pure American Indians and their culture apparently entirely American.

The origin of the Maya we shall allude to but briefly, since it is of small import whether they migrated from the north, south, or west, or developed in their present habitat. Their march toward civilization began possibly several millenniums B.C., when they, or more probably, the neighboring peoples of the Mexican highlands, first domesticated the wild Mexican grass *teocentli* and from it produced maize or Indian corn. With the beginnings of agriculture, life became

sedentary and comfortable, leisure time for the development of civilization increased, and the population grew. Later they added beans, squash, chili peppers, cotton, tobacco, cacao or cocoa, pineapples, and domesticated bees. The invention of the art of making pottery followed close on the heels of agriculture.

Up to the time of the Christian era, our knowledge of the Maya is mainly surmise, but the wonderful civilization that sprang into full bloom in the next few centuries presupposes many centuries of development. During this period the hieroglyphs were developed, though probably written on perishable mediums, and the foundations of all the arts were laid. The astronomical observations on which the calendar system was erected were also made during this time.

Maya history may be said to begin in 176 A.D., the date assigned to the first vague legendary statement in the historical chronicles. However, for the period of the Old Empire, which lasted until 600 A.D., the chronicles afford us no more than a few vague, general statements; the history of this period is derived almost entirely from the study of the actual remains and the dates as carved upon the monuments. The Old Empire of the Maya, which lasted more than four hundred years, is divided by students into three periods, an Early or Archaic Period to the year 357, a Middle Period to 455, and a Great Period to 600. During this time, dozens of great cities and hundreds of smaller villages were built by the vigorous people.

The oldest of the great cities is Tikal in Guatemala, where was erected the tallest building in the Maya region, attaining, with its pyramid, a height of 175 feet. The great city of Copan in northern Honduras was probably the most important of the cities of the Old Empire. The great hieroglyphic stairway, before its almost complete destruction by an earthquake, was probably the most extraordinary and wonderful sculptural product of aboriginal

THE UPPER STORY OF THE PALACE AT SAYIL, YUCATAN
This is an excellent example of the architecture and decoration of the late Maya Empire

RECONSTRUCTION OF TEMPLE II AT TIKAL, GUATEMALA

The model shows the edifice with its high roof court, the steep pyramid foundation, and the exterior stairs. The total height is 145 feet. From a model in the American Museum of Natural History made under the direction of Herbert J. Spinden

America. It consisted of some 90 steps, 25 feet in width and 125 feet in length, the risers of which were completely covered with carved hieroglyphs, composing an inscription of 2500 glyphs. It was built about 500 A.D. The architecture of Copan is typical of that of the cities of the Old Empire, the main buildings being grouped in a civic center upon great mounds of earth which elevated them like an acropolis. Large courts and plazas play a great part in the general plan. Upon the whole, however, the edifices of the Old Empire cities are rather plain and massive and without great interest; the artistic urge of the people found its expression in the sculpture of stelæ, altars, and similar independent figures rather than in the embellishment of their buildings.

The most typical city of the Middle Period of the Old Empire is Palenque, a large and well-known ruin in southern Mexico. Here, owing to an apparent lack of suitable stone for carving, most of the decoration is in stucco relief, which the Maya made by burning the plentiful limestone. In this modeling the Maya artist achieved as admirable results as in stone carving, and the stucco reliefs at Palenque are among the most admired examples of Maya art. In architecture, the most important feature is the tower which originally consisted of four stories, communicating by interior stairs. Buildings of more than one story and interior stairs are both of great rarity in the Maya area and speak highly for the ability of the Maya builders in those early days of architecture.

The Great Period or the Golden Age of the Maya reached its height at about the year 520 A.D., The acme of Maya culture was attained at this time, when they must have enjoyed a civilization above that of our Teutonic ancestors in Europe. About seventeen cities known to archæologists were flourishing in the foothills of northern Guatemala and the surrounding region. The arts and sciences were pursued and the common people must have had a comfortable existence.

The great city of this period was Quirigua in Guatemala. It is here that the most beautiful and largest examples of Maya sculpture are found, the architecture of the city being of slight importance. The stelæ, which, like those at Copan, bear dates indicating that one was erected every five years, are exceptional both for

their size and beauty.

About the year 600 A.D., for some reason which has not yet been determined, the great cities of Guatemala seem to have been abandoned. Numerous explanations have been advanced for this, such as devastating plagues of yellow fever, earthquakes, the impoverishment of the soil due to too intensive agriculture, or a change in climatic conditions with increase in rainfall. At any rate, no date later than 600 is found in any of the cities of the Old Empire. For the next three and a half centuries the Maya were in a period of transition, during which time, apparently, the center of the civilization moved from Guatemala northward toward the tip of the peninsula of Yucatan. Here sprang up the Maya civilization anew in a glorious renaissance which lasted from 980 to 1450. New, and even more beautiful and admirable cities sprang up; architecture, sculpture, and all the fine arts experienced a rebirth, but architecture rather than sculpture is the crowning glory of the New Empire.

Dozens of cities sprang up, of which three stand preëminent, Mayapan, Uxmal, and Chichen-Itza. Of these, the first two were founded in the Tenth Century, but Chichen-Itza had a far older history, having been first settled as far back as about 500 and subsequently abandoned. It has thus the longest recorded history of any city in America, 800 years. About the year 1000, these three cities, each the center of an important tribe and ruled by aristocratic nobles, formed a confederation by which the country was to be jointly ruled, and for nearly two centuries the land enjoyed peace and prosperity, the fine arts flourished, pyramids, temples, and other grand structures sprang up everywhere, and the land supported a great population. This period, from 1000 to 1200 A.D., was the New Golden Age of the Maya.

Today, only mounds mark the site of the

RESTORATION OF THE "TEMPLE OF THE TIGERS" AT CHICHEN-ITZA
(As proposed by Mandslay)

Photograph Through Courtesy of Prof. Marshall H. Saville

A PORTION OF THE GREAT HIEROGLYPHIC STAIRWAY AT COPAN, HONDURAS
Some of the the 2500 glyphs of the lengthy inscription are here shown in detail

mighty city of Mayapan, but the ruins of great Chichen-Itza and Uxmal still rear their stone spines above the Yucatecan jungle, attracting thither scientists and tourists from the world over. They are the most interesting ruins in America.

For, about the year 1190, jealousy and overreaching ambition put an end to the second Golden Age of the Maya, which had flourished for nearly two centuries. The nobles of the three allied cities fell out and civil war ensued. At first the quarrel was apparently between Mayapan and Chichen-Itza, and the resulting conflict changed the complexion of Mayan culture decidedly. The ruler of Mayapan seems to have called to his aid mercenaries or allies from the Valley of Mexico far to the northwest. These allies were the Toltec, the predecessors and cultural tutors of the Aztec. They enjoyed a high grade of culture, practically equal to that of the Maya themselves, with whom there seems to have been considerable interchange of cultural elements. The Toltec at this time had probably just passed the height of their glory, and their empire was beginning to disintegrate, as did that of the Maya after them. It was, however, nearly two centuries before the Aztec began their phenomenal rise to power. It is probable that the growing influence of the Toltec in Yucatan, exciting the hostility of the native Maya, was the primary cause of the civil war. Mayapan seems to have

ONE OF THE GEMS OF MAYA ART
This exquisite carved marble vase from the Ulna River, Honduras, is now in the Museum of the University of Pennsylvania

been the center of Toltec influence in Yucatan. Be that as it may, there is little doubt that the lord of Chichen-Itza plotted against his colleague of Mayapan, who, by Toltec aid, defeated him and took possession of Chichen-Itza.

Then began the Toltec regime in Yucatan, which lasted for about two and a half centuries, from 1200 until about 1450. Throughout the greater part of the country the alien presence left little mark, but in the three great cities the Toltec influence was strong. Uxmal held aloof and yielded to the new fashion only in the erection of a ball-court, but Mayapan must have been thoroughly Toltec in art and architecture. Chichen-Itza was enlarged and beautified by a number of imposing edifices in Toltec or Toltec-influenced style in a new section of the city.

AN EXCELLENT EXAMPLE OF MAYA POTTERY

A cup from the Department of Huepuetenango, Guatemala, which is now in the collections of the Museum of the University of Pennsylvania

Toltec buildings are differentiated from the Maya by a rather lighter and more flowing style, by buildings supported by columns, and especially by columns in the shape of conventionalized feathered serpents, the emblem of Quetzalcoatl or Kukulkan. The ball-court, examples of which are found at Chichen-Itza and Uxmal, is a Toltec element. Most of the more ornate and beautiful buildings at Chichen-Itza were built during this period.

Naturally the rule of the alien Toltec over the native Maya became more and more arrogant and unbearable, until at the end of two and a half centuries of oppression, the natives were goaded to desperate

THE SERPENT COLUMNS OF THE TEMPLE OF THE TIGERS

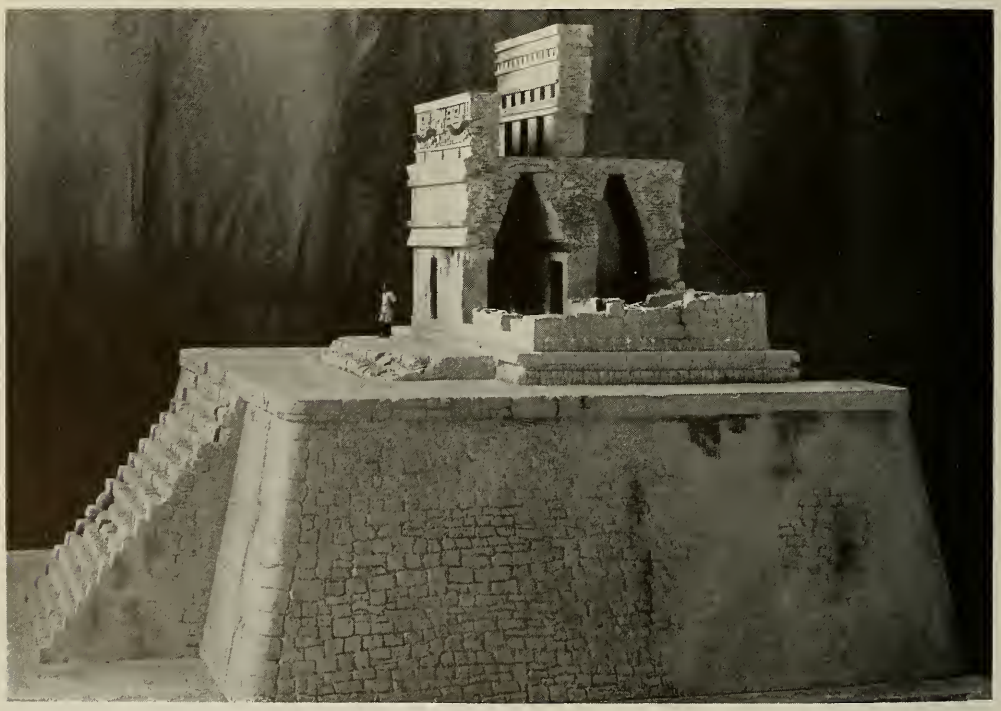
These columns, overlooking the Ball Court at Chichen-Itza, Yucatan, are typical of Toltec art and emblematic of Quetzalcoatl or Kukulkan

rebellion. Under the leadership of the lords of Uxmal, who had heretofore kept neutral in the conflict, the Maya forces united, attacked Mayapan, and slew all the members of the reigning house about the year 1450. Mayapan was so utterly destroyed that today but a few mounds and scattered stones are to be seen.

The fall of Mayapan marked the end of Maya civilization. Apparently the entire country fell into civil war and discord. Chichen-Itza, Uxmal, and most of the large cities were abandoned and no others built in their places. Famine and pestilence, the latter doubtless introduced by the earliest Spanish explorers along the coast, depleted their numbers, and close upon its heels followed the conquerors themselves with their muskets, ferocious dogs, and inquisitorial flames.

The independent spirit of the Maya was not entirely broken, however, and after three centuries of Spanish and Mexican rule they again revolted, and successfully.

Today the Maya Indians still inhabit the peninsula of Yucatan and much of Guatemala, their numbers estimated at 300,000. They are a fine race of American Indians, intelligent, sturdy, independent, industrious, and cleanly to a superlative degree. Many of them work in the great fields of agave or henequén from which comes our sisal hemp for binder-twine. Most of them speak nothing but the Maya tongue, and every Yucatan plantation owner speaks Maya as he does Spanish. But with the extinction of the leisured class, the priests and the nobles, all the accumulated wisdom and craftsmanship of millenniums were soon forgotten, and today only the great abandoned structures in the dense jungles bear witness to the heights attained by the Maya, one of the great nations of antiquity.



RESTORATION OF THE CHICHANCHOB OR RED HOUSE AT CHICHEN-ITZA

A classic example of late Maya architecture and the best preserved building in the Maya area. The model is sectioned to show interior construction, the flying façade, and the roof court. From a model made in the American Museum of Natural History under the direction of Herbert J. Spinden

DESERTED CITIES OF THE CLIFFS

The Great Southwest and the People Who Have Dwelt There.—An Account of the Cliff Dwellers and the Dwellers on the Mesas.

By PLINY E. GODDARD
Curator of Ethnology, American Museum

THE region called the Southwest in anthropological literature has been exceptionally productive of facts and information during the last twenty years. In this region of the Southwest is included all of New Mexico and Arizona and the southern parts of Colorado and Utah. Here grew up in the remote past a culture quite different from that found in other parts of America. The most striking characteristics relate to architecture and pottery. In Mexico, Central America, and the west coast of South America very large stone buildings were erected in ancient times, but it seems they were used as temples and palaces. The dwellings were small and usually temporary and perishable. In the Southwest are many buildings, inhabited and in ruins, covering great spaces of ground and reaching a height of several stories. These were devoted chiefly to the housing of the people and the storage of their food supplies.

To a great extent in America pottery in some form was made for household uses. The pottery of the Southwest is quite distinct in its decorative features, and recent finds make it seem probable that it had a fairly independent development. Associated with the communal life of these urban people is an interesting social and governmental organization with elaborate and numerous rites and ceremonies.

A fair description of these Indians and their ways of life may be found in the accounts of the Coronado expedition dating from 1540. There are several other reports in Spanish, written during the Sixteenth and Seventeenth Centuries. The American occupation dates from 1846. A number of interesting descriptions of the country and people were written by Americans who visited the country in official capacities, but the first real studies were made somewhat later.

As elsewhere the studies in the Southwest are divided into two groups, those related to the remains of people no longer existing, and those concerned with the living people. The first is known as archæology and the second as ethnology. The methods employed are quite different, and each attracts students of different temperaments and interests.

The first archæological accounts are by members of the U. S. Geological Survey. One of the early ones is by W. H. Holmes who, in the summers of 1875 and 1876, accompanied the U. S. Geological and Geographical Survey of the Territories as artist. During the same two years and in 1877 W. H. Jackson was on this survey. Both wrote accounts of the ruins in the San Juan drainage. Professor Holmes later became chief of the Bureau of American Ethnology at Washington, and curator of anthropology in the U. S. National Museum. The first systematic archæological studies in that region were carried on by A. F. Bandelier under the auspices of the Archæological Institute of America. This work was begun in 1880 and continued until 1910. It was largely descriptive in character. In 1893 Nordenskiold, a member of a noble Swedish family noted for their scientific interests, wrote an account of the cliff ruins of Mesa Verde in southern Colorado.

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CLIFF DELLINGS IN THE RITO DE LOS FRIJOLES

The "cavate lodges" honey-combing the north wall of this picturesque cañon, represent for the most part, back rooms of the thirteen villages that formerly stood on the talus slope, but of which few vestiges now remain

The American Museum began in 1895 the excavations of Pueblo Bonito, one of the largest of the ruins in the Southwest. This was financed by B. T. B. Hyde and his brother, who also acquired important collections from southern Colorado and Utah. Mr. George H. Pepper had charge of the work at Pueblo Bonito and of the collections secured by purchase.

The next active period of archæological work began about 1910. The main participants have been Peabody Museum of Harvard University, Phillips Academy of Andover, Massachusetts, the Archeological Institute of America, Smithsonian Institution through both the National Museum and the Bureau of Ethnology, the Museum of the American Indian (Heye Foundation), the National Geographic Society, and the American Museum of Natural History.

The Peabody Museum has devoted its work chiefly to the western portion of the San Juan drainage, where very important discoveries have been made by Samuel Guernsey and A. V. Kidder. Phillips Academy, with Doctor Kidder in charge, has completed a very thorough excavation and examination of the Pecos ruin, which was abandoned by its inhabitants in 1838. The Archeological Institute, under the direction of Edgar L. Hewett, did important excavation and repair work on the Pajarito Plateau and in Frijoles Cañon west of the Rio Grande. The work of the U. S. National Museum and the Bureau of Ethnology represented by Walter Hough and Jesse W. Fewkes, respectively, has been chiefly at Mesa Verde and the Little Colorado and Gila River drainages in Arizona. The Museum of the American Indian, with F. W. Hodge in charge, excavated the Zuñi ruined pueblo of Hawikuh, and has done important work in Nevada, superintended by M. R. Harrington. The National Geographic Society has financed five seasons of work at Pueblo Bonito, which has been conducted under the management of Neil M. Judd. The American Museum began its work in the Galisteo region of New Mexico with N. C. Nelson in charge, and later

undertook the excavation and repair of Aztec ruin on Animas River in northwestern New Mexico. The latter undertaking has been conducted chiefly by Earl H. Morris.

More recently extensive work has been done by Doctor Kidder and Mr. Morris in the two cañons, del Muerto and de Chelly. Not all the institutions and individuals concerned have been mentioned, but from the above enumerations the scope of the work will be apparent.

All this is preliminary to an appraisal of the results obtained in the form of knowledge during the last eighteen years. In 1910 we knew there were extensive ruins abandoned before the Spaniards arrived in 1540, and that the people who had inhabited them were agriculturists, growing cotton, as well as corn, beans, and squash; that they made excellent cloth of the cotton for their wearing apparel; that, while they made baskets, their household vessels were in the main chiefly made of clay. These pots were known to be beautifully decorated, chiefly by the use of designs painted in black on a white background. From southern Utah a culture believed to be different and perhaps earlier, had been named Basket-Maker, since they were known to make excellent baskets but no pottery. Aside from the last inference as to time, nothing was known about the time relations in the Southwest except what had been recorded by various writers since the Spaniards took over the country.

Mr. Nelson in his work in the Galisteo valley had a date, that of the rebellion in 1680, as the most recent in that region. It was also possible to determine with considerable accuracy whether a village site had been occupied after Spanish times, since the bones of domestic animals and objects of European manufacture were certain evidence of later occupation. He next attempted to arrange the various sites in the order of their dates on the basis of the pottery finds. The pottery vessels first had to be arranged in a time sequence. This he attempted to do by finding buildings containing one type superimposed on others which, of necessity, would be older. Failing in finding conditions of this sort in

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THE ANCIENT VILLAGE OF TYUONYI

This great community house was the principal focus of population in the Rito de los Frijoles. It was a terraced structure, built of blocks of tufa, and the débris indicates that it was three stories in height

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THE HOPI VILLAGE OF WALPI

From their homes on the mesa top these villagers may keep a watchful eye on their fertile fields below, and also on the surrounding plain, a circumstance of great value in the days when enemy raids might be expected

sufficient number and variety to settle the problem, he resorted to a rubbish heap, which he sectioned from top to bottom. At the top were evidences of post-Spanish occupation. As he went down, there were gradual pottery changes corresponding to time sequences. The results obtained in this manner checked with his finds in superimposed buildings.

Doctor Kidder at the same time was studying the pottery in the region of the Pajarito plateau. This method of using the stratification of the rubbish heaps as a measure of the true relations of pottery was used brilliantly by Leslie Spier in the region of Zuñi, New Mexico, by Earl H. Morris in his work at Aztec and elsewhere, and by Doctor Kidder and those associated with him. We know now not only the chronology of ceramic development in the Southwest, but we know the local variations in form and decoration. By means of the pottery, the remains of the particular rooms in a ruin can be given a date relative to others. It appears that considerable trading took place, and by means of traded pottery it is possible to say that certain villages in the Southwest were occupied contemporaneously. Since the ruins can be arranged in a time sequence on the basis of the pottery, the history of architecture is also discoverable.

Briefly, we know that there were a people in the Southwest who raised corn of two varieties, who made excellent baskets, whose houses did not survive, but their practice of burying the dead with accompanying objects in dry caves left a definite record of them. These people are the Basket-Makers, so named by Mr. Pepper. Mr. Guernsey, of the Peabody Museum, has made the most noteworthy contributions to our knowledge of these people. Following them were a people of similar culture but who began to experiment with clay for the making of house-

hold vessels. The clay was mixed with corn husks or shredded cedar bark, molded in baskets, and dried in the sun. The houses were made by placing stones on edge in a circle and erecting a dome-shaped hut above them, which was covered with bark and plastered with clay. These people have been called the Post-Basket-Makers. Our most detailed information concerning them comes from Mummy Cave in Cañon del Muerto. The work was done by Doctor Kidder and Mr. Morris, but has not yet been published.

Following these were a people who made proper pottery, decorated crudely with painted designs and well fired. Their houses were similar to those described above, but they soon began the erection of rectangular houses of stones laid up in adobe clay. These houses contained several rooms above ground and an underground chamber called a kiva. These people have been known as the Pre-Pueblo people.

Following was the Pueblo period, when the people gathered together and produced the many-roomed buildings for which the Southwest is famous. Some of these stood in caves and have been splendidly preserved. Among them are Spruce Tree House and Cliff Palace in the cañons of Mesa Verde, Betatakin in Northern Arizona, White House in Cañon de Chelly, and the great ruins in Mummy Cave, Cañon del Muerto. Other buildings of the same period were built in the open. Those of Chaco Cañon, (which include Pueblo Bonito), and the ruin called Aztec, are examples of this period. Not only is the architecture of this period the most ambitious, but the pottery is superior to any produced earlier or later.

For some reason many of the outlying regions were completely abandoned at the end of this period. The most probable cause was the pressure of enemies, better warriors, no doubt, than the sedentary agriculturists. Following this in the east there was experimentation with a glaze paint for pottery decoration, and in the

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A NEW MEXICO SKYSCRAPER

The Tigua village of Taos, beloved of artists, boasts of a greater height than any other pueblo of the Southwest, rising to seven stories. It is a conservative community, and retains many of its ancient religious practices

west the use of white and black on a yellow ground. The eastern settlements were slowly yielding when Coronado arrived, introducing certain phases of European culture. The most readily accepted contributions from Europe were metals and domestic animals. Christianity, as represented by the Catholic Church of the time, was accepted reluctantly and only in part.

The work among the living peoples began with Frank Cushing, who resided in Zuñi, one of the larger villages, from 1879 to 1884. Doctor Fewkes took over the work which had been supported by the Hemingways of Boston, and turned his attention chiefly to the Hopi. The American Museum began its active work in 1909 under a grant made by Archer M. Huntington. Dr. Herbert J. Spinden spent several seasons mainly in the Rio Grande villages, Dr. A. L. Kroeber was in Zuñi for a summer, Robert H. Lowie investigated the Hopi, and Leslie Spier made a thorough study of the Havasupai. Much important work has been done by Dr. Elsie Clews Parsons, personally, and by others working with funds supplied by her. Doctor Parsons and Dr. Ruth F. Benedict have done much at Zuñi, Prof. Franz Boas at Laguna, Mrs. Esther Schiff Goldfrank at Cochiti and Isleta, and Leslie White at Acoma. Dr. Ruth Bunzel has acquired a speaking knowledge of the Zuñi language and is engaged in a minute story of Zuñi family, social, economic, and religious life. Her work has received the support of Columbia University and the Social Research Council.

It is too early to summarize the results of this ethnological work. The social and religious life is very complicated, and the latter evidently subject to constant change. There are important differences between the various villages, and evidences of borrowing back and forth. Just now there is much interest displayed in the separation of elements contributed by or adapted from the Spaniards.

No other region has yielded so much; no other region promises so much for the future.

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A CEREMONIAL CHAMBER

Ninety feet of ladders and 200 feet of rock trail and stairway must be climbed to reach this ancient kiva, burrowed into the floor of a cave high up in the cañon wall at the Rito de los Frijoles

PEOPLE OF THE FOGGY SEAS

The Aleut and Their Islands

By WALDEMAR JOCHELSON
Former Division Curator of the Museum for Anthropology and Ethnography of the Russian Academy of Sciences in Leningrad

The author of this article spent the years 1909 and 1910 among the Aleutian Islands as the head of the Anthropological Division of the Aleut-Kamchatka Expedition that had been sent out by the Imperial Russian Geographical Society of St. Petersburg (now Leningrad). Heretofore only his "Archæological Investigations in the Aleutian Islands" have been published (Carnegie Institution Publication, No. 367, Washington, 1925), and the following article, therefore, contains material never before presented to the public.—The Editors

FOR about one thousand miles the Aleutian Islands stretch from the Alaskan Peninsula in a long bow-shaped chain of seventy treeless islands, excluding the numerous islets. All of the islands are of volcanic origin, and are covered with high mountains, among which are both active and extinct volcanoes. The shore line is irregular, the rocky mountains sloping abruptly to the sea. The bays are shallow, full of reefs, and dangerous for navigation.

The vegetation is luxurious though limited to grasses, berry-bearing shrubs, creeping bushes, and varieties of low willows. On the mountain slopes we find an alpine vegetation and various species of mosses and lichens. In the narrow valleys between the mountain ridges and on the low isthmuses with insufficient drainage, are fresh-water lakes with hummocky shores, such as characterize the Siberian tundras. The hummocks are covered with sedge grass. The absence of arboreal vegetation is due not to the climate, which is comparatively mild, but to the constant gales, and to the fogs and mists that are encountered in Aleutian waters, and that deprive the plants of much sunlight.

The fogs and gales result from the meeting of two extreme currents—the cold from Bering Sea and the warm, Kuro-Shivo, from the Pacific.

During the visit of the Kamchatka-Aleutian Expedition to these islands, I made regular meteorological observations, using a centigrade thermometer. For the period from March 1, 1909, to March 1, 1910, the annual mean was 3.9 (39° F.), with a maximum of 16.5 (62° F.) (on the island of Atka, August 12, 1909), and a minimum of–13.0 (9° F.) (on the island of Umnak, February 1, 1910). There are only two seasons: a long autumn and a short, mild winter. But the incessant winds and gales cause the slightest cold to be felt and, in summer particularly, the constant fogs hide the sun. Throughout my nineteen months' stay in the islands, the sky was clear only nine days.

Some of the Aleutian Islands were densely populated, and it has been estimated that nearly 30,000 natives inhabited them when the Russian invaders arrived there in 1745. The Aleut throve on sea-otter and other game, an important part of their diet being the palatable meat of the "sea cow," a sea mammal described by Steller, the naturalist-explorer and member of the Bering expedition. All these sea mammals were exterminated by Russian and other white hunters. Deprived of food resources, and with rapacity and exploitation rampant, the Aleut decreased in numbers.

According to official data in 1910, the total number of Aleut was 1232. Of these,

DOCTOR AND MRS. JOCHELSON BESIDE
A WATERFALL ON ATKA ISLAND
Mrs. Jochelson was anthropologist of the Aleut-Kamchatka Expedition and assisted her husband in the excavations on the Aleutian Islands (1909–10) and on Kamchatka Peninsula (1910–11)

221 were in the nine settlements of the Alaska Peninsula; 9 lived on the Shumagin Islands (Simonovsky and Wosnesensky); 282 dwelt on the Pribilof Islands (Saint Paul, 195; Saint George, 87); and 479 were on the Aleutian Islands (Sanak, 36; Unimak, 9; Akutan, 51; Biorka, 46; Unalaska, in five villages, 383; Umnak, 100; Atka, 77; Attu, 62). Adding to the Alaskan Aleut, the 501 Russian Aleut of the Commander Islands (Copper Island, 234; Bering Island, 267), according to my data of 1911, we arrive at a total of 1733 Aleut.

At the time the above figures were gathered, the non-Aleut or white population in the Aleut territory numbered 237. It was not evenly distributed, the greatest number of whites living on the island of Unalaska. On the Siberian Commander Islands were 51 white people; on the Pribilof Islands only 9 (chiefs, doctors, priests, school teachers, and government storekeepers).

On the Pribilof Islands sealing is carried on under the U. S. Government, and the islanders are regarded as Government laborers. According to existing regulations, no outsider may land on the Pribilof Islands without a special permit from the U. S. Government. This restriction also applies to the crews of the revenue cutters cruising around the islands during the summer. On the other hand, short leaves of absence are reluctantly granted and no Pribilof Aleut is permitted to return home after a year's absence. The Pribilof Aleut, however, appear to be happy and healthy.

Of great interest are the regulations concerning the killing of fur seals and the remuneration of the killers. All the adult Aleut take part in the killings. Almost every day during the summer, fur seals from one rookery or another are cut off from escape by the sea and are driven inland. About half a mile from the shore the herd is examined. Females, old males, and puppies are selected and returned to the coast, and the males between two and

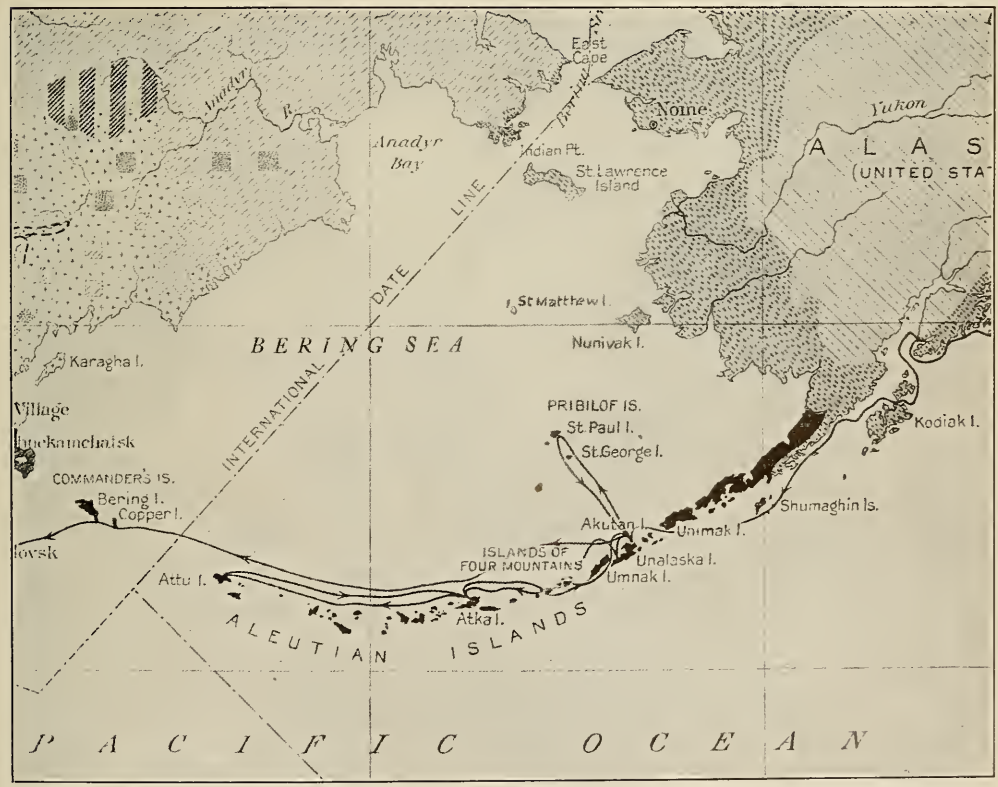
five years old are driven to the killing places. The slaughter presents a most painful spectacle. The animals are clubbed senseless by blows with long sticks, after which their throats are cut, and they are skinned.

The community is credited with two dollars for each seal killed, and each family head has an account with the Government store, where he can obtain ready-made clothing, imported food, tools, instruments, and other needed commodities, as well as luxuries. Toward the end of the year, the hunter receives his balance in money, and in case of an excess, the difference is carried over to the account for the following year. Large families receive more than small ones, regardless of the number of hunters, and widows and orphans of men who have died in the Government's service receive their shares.

Sealing is a profitable business. For instance, 21,302 sealskins were sold in 1927 for $745,410, and 728 blue foxes, which abound on the islands, were sold for $38,729.

The Aleut are comfortably housed. Each family has a nice cottage, and receives stoves, coal, electricity, and in general is well provided for.

All these regulations and arrangements were adopted from the Russians when Alaska was sold by them to the United States, but with this difference: there are no abuses under the American administration. On the whole, however, the Pribilof Islands, with all their abundance and happiness, seem to me to be more like



MAP OF THE ALEUTIAN ISLANDS AND VICINITY
The Aleut territory is indicated in black, and the route taken by Doctor Jochelson throughout the Islands is also outlined in black

ALEUT HUNTERS

When he goes down to the sea, the Aleut hunter wears a waterproof shirt made of intestines of sea mammals and ornamented along the seams with the down of gay-colored birds. Long throwing darts are also part of the outfit. The painted wooden ceremonial hats, decorated with sea-lion's whiskers, are relics of former times, and are now replaced by the small wooden eyeshade shown on page 417

an honorary penitentiary.

The poorest of the Aleut are those who live on Attu Island, where there are no seal rookeries at present and where the sea mammals were exterminated by foreign hunters. These people have no skins for skin boats, they go almost naked, and during the winter suffer from famine.

To learn what has happened to the Aleut since my visit, I have looked over the reports of the Governor of Alaska to the Secretary of the Interior for the last ten years, and was surprised to find no mention of these people. Among the Alaska public schools are named those of Umnak, Kashega, Unalaska, Akutan, and Belkovsky,[1] and in the report of 1923 I find information of a plan to introduce herds of sheep into the western ends of Unalaska and Umnak Islands. These localities are covered with grasses, lakes and rivulets, where sheep may thrive, and in the mountainous districts reindeer could be raised. In 1909 when the chief of the Bering Sea Patrol Fleet, Capt. William V. E. Jacobs, asked my opinion on this subject, I furnished him with samples of several species of the lichens on which Siberian reindeer feed, and which grow also on the mountains of the Aleutian Islands.

[1]In 1910 there was also a school on Atka Island.

RELIGION

The old beliefs of the Aleut were of a complicated character. Evil spirits (*kugan*), causing sickness and death, were fought by shamans, conjurers, and the spirits of departed relatives. The souls of the dead (*angix*) visited relatives to protect them. Relatives—parents and children, husbands and wives—were greatly attached to one another.

Parting with the dead was deferred as long as possible. The corpses, particularly those of children, were kept in the dwellings, the relatives watching and sleeping near at hand. Fear of the dead, at least of related dead, was unknown to the Aleut, since they conceived of those departed, not as hostile spirits, but as the same loving beings they were in life.

Under such circumstances it is scarcely to be wondered at that the Aleut learned to mummify the bodies of their dead, thus making their preservation possible, and postponing the time for final disposal,

which was effected mostly in dry caves. The corpse was arrayed in its best clothing, over which was drawn a waterproof shirt made of the intestines of sea mammals. Then the body was arranged in a squatting position—a favorite posture of living Aleut when resting—with knees drawn up to the chin. Wrapped in closely plaited grass-mats and seal or sea-lion skins—for a man these were taken from the cover of his boat—the corpse was lashed into a compact bundle with thongs or seaweed ropes. The whole was wrapped in a net made of sea-lion sinew.

The folklore of the Aleut has been influenced by that of the Eskimo, the North Pacific Coast Indians, and also of the Palæ-asiatic tribes of northeastern Siberia. There are, however, many genuine Aleut tales which relate to animal guardians, or we may say, to personal totems. Every ancient Aleut received from his father or a shaman, an animal protector or *ugdux* in the shape of an animal's skin. This was worn in times of danger, struggle, or contest, to help transform the wearer into the corresponding animal, and thus receive its protection. The Aleut had many colored wooden masks representing animal and human monsters, which were worn during religious and social dances and festivities. The dances were actually dramatic presentations.

The conversion of the Aleut to the Greek Orthodox Church, which was consummated in the time of the missionary Veniaminoff (1823–1833), resulted in the obliteration of old institutions, beliefs, ceremonies, and customs. Veniaminoff put an end to the cruelties and exploitation practiced by the Russian hunters and officials against the Aleut. In Unalaska there is a comfortable Methodist home for Eskimo and Aleut children. But even impoverished Aleut parents would not allow their children to live in this home. Orphans placed there by the American authorities would return to the Russian Church after they had grown up and had left the home.

It is touching to observe how poor Aleut hunters and laborers will give their mite to embellish their churches with candelabras and lustres, and with icons and saints painted in Russia by good painters.

When I was among them, the Aleut were teaching one another to read prayers

A HUNTER OF ATKA ISLAND

A rain shirt of seal intestines and waterproof boots of sealskin protect the hunter from the elements. Behind him may be seen a skin boat of the one-hatched type

A MIXED-BLOOD ALEUT-RUSSIAN WOMAN
Her children show a reversion to the Aleut type

in the Church-Slavonic language, incomprehensible to them, although the prayers are translated into Aleut and English. Once a year the Russian priest of Unalaska would visit the distant western settlements of his parish to administer the Communion and perform marriages and rites of baptism; but during the whole year there was a reader in each village who read in the local chapel not only prayers proper for laymen, but also the entire Mass, which usually is done only by a consecrated priest. The whole community formed the choir.

SOCIOLOGY

While the Aleut beliefs fully capitulated to Christianity, some ancient family customs have survived to the present. Of course this is not obvious to the casual observer, but the curtain may be lifted when the investigator knows the language of the people. With this in view, I devoted the first year of my stay among the Aleut to the study of their language. I found many ancient marriage customs still surviving — both polygyny and polyandry being practiced in the case of a man living with the younger sisters of his wife, and of a woman living with the younger brothers of her husband. In olden times a man might have as many wives as he could provide for and a woman as many husbands as she could keep house for. But this individual liberty in marital relations does not mean that there was no real love or jealousy; the contrary may be learned from ancient Aleut tales.

SOMATOLOGY

During historical times the Aleut have intermarried with Russians, and after them, to some degree, with other whites, chiefly Americans. But this interbreeding has had little influence on the original physical type. Among the Aleut we encounter some bearded men and light-complexioned and light-brown-haired women, but on the whole the Aleut have preserved their original somatological traits. Many of them have the dark skin color, broad faces, and Mongoloid eyes of the original stock. The cephalic index of the living corresponds to that of the skulls of ancient Aleut. The measurements of 138 living people (men and women) taken by Mrs. Jochelson gave a cephalic index of 84, with a standard deviation of 3.3, and the measurements of 50 well preserved skulls from prehistoric graves gave an average cephalic index of 82.1, with a standard deviation of 2.7. According to Broca, 2 units may be added

to the cephalic index of skulls to obtain the cephalic index of the living. Adding, 2 units to 82.1 (cephalic index of our Aleut skulls) we obtain 84.1.

THE ALEUT LANGUAGE

The Aleut language is divided into three dialects:

(1) The eastern, or Unalaskan.

(2) The central, or Atka.

(3) The western, or Attu.

The Unalaska dialect is spoken on all the islands to the east of Umnak (Umnak included) and by the Aleuts of the Alaska Peninsula. The Aleut language belongs to the Eskimo stock. It has been impossible as yet to make a detailed comparison of my extensive Aleut dictionary with the published Eskimo vocabularies, but even a superficial survey of the latter shows many common elements. I analyzed the grammar of the three dialects of the Aleut language and found its structure is based on the word formation common to other Eskimo dialects. The modification of Aleut verbs, with its two formal processes of incorporation and polysynthesis, characterizes, perhaps in the best way, the Eskimo-like structure of the Aleut language.

I have already mentioned the influence of the missionary, Veniaminoff, on the beliefs and life of the Aleut. Since Veniaminoff's time the Russianization of the Aleut proceeded so rapidly that, had it not been for the purchase of Alaska by the United States in 1867, the Aleut language would have long ago ceased to exist, and would have been replaced by Russian. But the U. S. Government, after acquiring Alaska, left the Aleut to themselves for a long time. During this period the Russian influence ceased and the American had not begun. The Aleut gradually forgot the Russian language, with the exception of reading (but not comprehending) the Church-Slavonic used in the church service, and returned to the tongue of their forefathers. Thus the Aleut language was preserved in the elder generation until our day. Only after big commercial interests had gained ground in Alaska and a governorship was established, did the United States Government turn its attention to the matter of the enlightenment of the Aleut. This was in the middle of the eighties of the last century. Although at present not all the

A WOMAN OF UMNAK ISLAND

The baby is carried on its mother's back in a skin cradle, made soft and snug with a lining of fur, while the mother's coat is fashioned of birdskins, with the downy side turned inward

A GENERAL VIEW OF THE VILLAGE OF NIKOLSKOYE, UMNAK ISLAND
The red and the dog salmon that ascend the river are caught in traps consisting of two fences, one of stone and the other of wood, stretching across the stream

Aleutian Islands have American schools, the young Aleut already have an imperfect knowledge of their native language and the time is not far off when it will be entirely replaced by English.

SALMON DRYING ON ATTU ISLAND
The fish are split and hung on racks to dry before being stored away for the winter's food. This work is entirely the responsibility of the women and children

MATERIAL CULTURE

Since the separation of the Aleut from their Eskimo kinsmen of the American continent, their material culture changed, owing to differing climatic and other conditions.

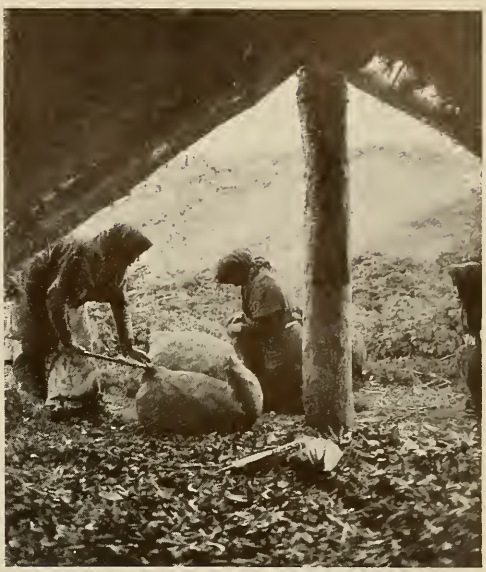
The Aleut have no driving dogs or other domestic animals. All the settlements are situated on or near the shore, and communication between them is by means of skin boats and sometimes by walking. The ancient Aleut used skin boats with a single hatch, but very seldom did a hunter venture alone into the open sea. They hunted in pairs or groups in order to help one another in case their boats capsized in the rough waters. At present most of the Aleut skin boats have two or three hatches. Nevertheless, seldom does a single boat venture into the sea.[1]

On land small bows and arrows were formerly used to shoot animals in their rookeries. These were employed also against landing parties of hostile warriors. The Aleut of the Alaskan Peninsula, how-

[1]The ancient Aleut also had large skin boats called by the Eskimo *umiak*, but they are not in use at present on account of the lack of skins of sea lions or other large sea mammals.

ever, lacking firearms, still use the bow in hunting wild reindeer, bears, and other land animals. When sea mammals are hunted from boats, light darts cast by means of throwing-boards are used. These are thrown with the right hand, while with the left the hunter steadies the skin boat by holding the double paddle across it. For stringing a bow both hands are necessary, and besides, the bowstring recoils when released, and if used in the light skin boat, the craft might be capsized. Eskimo hunters likewise use the bow only when hunting land animals. The force of a thrown weapon in flight is considerably less than that of an arrow shot from the bow.

As the sea surrounding the islands does not freeze, the Aleut are not acquainted with the Eskimo method of hunting aquatic mammals through ice-holes or from floating ice-cakes. Therefore, some of the Eskimo winter-hunting implements were not developed by the Aleut. These were the composite bow, hooks for catching ice-blocks, ice-scrapers, bone picks for making ice-holes, snow-knives, snow-beaters, snow-shovels, ice-scoops, snow-goggles, and snowshoes. In the Aleut excavations no crescentic stone lamps and no lamps with bridges for the wicks were found. The Aleut did not cook over the stone lamps. The absence



THE FINAL STAGE IN PRESERVING THE SALMON

Sea-lion stomachs are cleaned, dried, and used as storage receptacles for the dried salmon

PREPARATIONS FOR THE SHORT WINTER

The skin coverings are stripped from the boats and stored under shelters to protect them from the winter gales. Otherwise they would dry out and break

A GROUP OF ALEUTS, UMNAK ISLAND, CLUSTERED NEAR ONE OF THEIR EARTH HUTS

TOSSING A GIRL ON A BLANKET (INSTEAD OF A WALRUS HIDE). A GAME KNOWN ALSO AMONG THE AMERICAN ESKIMO AND SIBERIAN CHUKCHEE

A LARGE SEAL ROOKERY ON THE ISLAND OF ST. GEORGE

ON THE PRIBILOF ISLANDS SEALING IS CARRIED ON UNDER THE UNITED STATES GOVERNMENT. ONLY MALE SEALS FROM TWO TO FIVE YEARS OLD ARE TAKEN

in the excavations of large stone axes may be explained by the complete absence of growing trees. For splitting pieces or logs of driftwood along their length, bone wedges and stone hammers were sufficient, and for chopping these splinters they used small stone adzes. Neither did the Aleut adopt the Eskimo type of pottery, which consisted of vessels and lamps of burned clay. The ancient Aleut consumed food either raw or roasted on stone slabs.

The art of weaving has been well developed by the women. Some of the objects woven from the split blades of *Elymus mollis* are so finely plaited that they have the suppleness of silk.

CULTURE FEATURES SIMILAR TO THOSE OF THE ESKIMO

The typical large slate tailoring knife (*ula*) used by the women was found in all the excavations on the Aleutian Islands. The Aleut call it *igadax*. The method of ornamenting bone objects by engraving them in geometrical designs with stone engravers and awls, and then filling the depressions with paints of different colors, is like that of the Eskimo. Of the Eskimo type also are the modern Aleut realistic representations of animals engraved on bone objects, and the realistic carvings in bone and wood.

CONCLUSION

Of all the uncivilized peoples I have studied in Siberia and Alaska, I feel most sympathetic with the Aleut. They endure physical suffering and privations without complaint; they are simple in their behavior, unselfish, friendly, and perfectly reliable. They have a sense of self-respect, and are reserved toward strangers. Backward they may be, but admirable they certainly are.

INTERIOR OF THE GREEK CATHOLIC CHURCH, UNALASKA

The priest is standing beside the entrance to the inner sanctuary, the doors of which are opened during the celebration of the Mass. This entrance is called in Russian "The Czar's Door"

SAILING DOWN THE MOONLIT WATERS OF THE YALU RIVER

WINGS ON THE YALU

By WILLIAM DOUGLAS BURDEN
Trustee of the American Museum

AT Peking, where I was to join Mason Sears for a pursuit of the great Asiatic sheep on the Sino-Mongolian frontier, I heard of conditions on the Yalu River, border of Manchuria, which sent me off at once on a hurried preliminary trip.

I had been given to understand that there were millions and millions of ducks and geese down on the lower reaches of that river in September, and, although I could not verify the statement in Peking, the prospect was so inviting that I decided to go. Accordingly I wrote of my intentions to the American consul at Antung.

The Yalu River forms the boundary between Manchuria and Korea. The Port of Antung is on the Chinese side of the river, but, to all intents and purposes, the Japanese control the city. They own the silk which is exported in such large quantities, and they own the lumber which comes down the river from the Manchurian forests to the northward.

The natural beauty of Antung itself is nothing to boast of, and the sight that greets your eyes when you get off the train at five o'clock in the morning may well be left undescribed. A rickshaw was at hand, and I proceeded to the "Eagle's Nest"—the American Consulate—a little hovel situated on high above the city, of which we should properly be ashamed. Mr. Langdon, the consul, met me at the gate, and I was delighted to find that all necessary arrangements had been made for a trip to the mouth of the river.

A few hours later we were on our way, Langdon and I sprawled out on the deck of our sampan, while a pair of "missing links," who squatted on their haunches in the stern, guided our craft through the maze of junks that lined the bank four and five rows deep. The sampan was ours for three days at approximately fifty cents a day, and the luxury we enjoyed was in proportion to expense. We hoisted sail and the wind and tide helped us on our way.

The river life was fascinating. Here coolies were unloading lumber, chanting as they worked. Never have I listened to such cadence or swing. It sounded almost

JUMPING OFF INTO GURGLING MUD
Yachting on Long Island Sound and junketting on the Yalu have nothing in common, but the latter is worth trying

like a roundelay, with a soloist to give the cue. Russian boat songs are famous for their sweep and rhythm, but nothing could be more enthralling than this singing on the Yalu River. When a large number of men sing as they work, the energy that they put into their work is revealed in the song, and the rise and fall of hundreds of voices, coming across the water from a distance, is thrilling.

Other junks, laden to the water's edge, were being towed upstream by means of ropes attached to the bank, and every heave was accompanied with a renewed burst of song. But all this activity I am describing was Chinese. The lazy Korean anchored his boat and sat motionless, pipe in mouth and cage-wire hat on head, and waited for the turn of the tide.

By the middle of the afternoon we had reached the flats, and here we beheld a most extraordinary thing—countless millions of birds. As Langdon said, it was the sort of thing you read about, but seldom see yourself. Sometimes the sky was black with geese, and sometimes black with ducks. Sometimes it was the water that was covered with them in every direction as far as the eye could see, and sometimes the flat mud marshes for miles on end were alive with moving bodies. When all the geese flew up together, the noise of their wings filled the air, sounding one moment like an express train and the next like some gigantic waterfall. It was a paradise for the ornithologist; I don't believe that there is anything else in the world like the lower reaches of the Yalu River in late September.

We hunted till dark. We had no "blinds" of any kind, so the hunting consisted largely of wading around knee-deep in the softest kind of mud, scaring up the birds as we went. It was almost hopeless—a real "wild goose chase."

With millions of targets dangling before our eyes, it was astonishing how hard it was to score a kill. When there was sufficient cover in the form of long grass and reeds to use as a blind, the only geese that

flew over it were high out of range. We had to lie down in the soft, wet mud and, while trying to resemble a log, crane our necks in every direction to be ready for any bird that happened to come close enough for a shot. When a bean goose was seen coming over, we would wait till the very last moment before making a move. Then we would jump up and shoot as quickly as possible. By the time we could fire, however, the goose would already have turned. Under those conditions, the satisfaction of seeing a great gander come tumbling out of the sky with a flop into the mud can well be imagined. It was shooting under difficulties, but before dark we got about eighteen birds—Asiatic duck, mallard, teal, and geese,—and we had worked hard for every one.

At sunset, tremendous flocks of ducks, stretching out sometimes for a quarter of a mile in the sky, went whirring overhead—always too high—and away into the west. Flock after flock came by in endless succession, teal and then mallard, then Asiatics and more mallard. Away they went, with the speed of the wind, into the sunset. One could keep them in sight for several minutes, a scattering of black dust against the crimson sky, and then they would swing south on their great migration. Thousands upon thousands upon thousands of duck must have left the marshes that evening. As it grew dark, one could no longer see, but one could still hear them—the whistling of millions of wings passing overhead.

Finally we slopped back in the mud to our sampan, and crawled up on the ridiculous little craft. Most of the mud came with us, and Langdon's setter took care to shake himself over everything. We were soaked through and caked with mud from head to foot. A cold wind came off the marsh. There was absolutely no prospect of our getting clean or warm, or of satisfying a ravenous appetite. When it got too cold on deck, we crawled

ON THE YALU RIVER

Man may well have separated from the anthropoid stem many millions of years ago, but who can fail to note in these prognathus jaws and in the character, facial expression, and pose of the gentleman at the right, an unmistakable simian resemblance

down into a black manhole which in every way resembled a coffin. All sampans have these miniature dungeons below decks, and they are cunningly contrived in true Chinese style so that they are too low for one to sit up in and too short to lie down in. Moreover, when the lid is on, not a breath of air can get in. Langdon and I found ourselves trying to eat supper by candlelight in this den. I almost lost my appetite when I saw hundreds of shiny-backed cockroaches of all sizes crawling over the place. The prospect of spending the night with roaches that were compan-

A PARADISE FOR THE ORNITHOLOGIST

When cold storage shipping methods were introduced in China, the slaughter of game birds in the Yangtze valley was without parallel. Fortunately the mouth of the Yalu River is still a safe stopping place for these migratory birds

ionably inclined did not seem conducive to sleep, but none the less it was managed. Lao Li (Old Forest) and his assistant boatman could do nothing to make us comfortable, for neither of us could give orders in Chinese, and, needless to say, they were unable to understand a word of English. It pleased them to observe the foreigners shifting for themselves.

As I dozed off to sleep, I could still hear geese honking on the mud flats—just a jumble of sound it was, broken occasionally by the wild cry of some lonely gander flying low overhead in search of a night's resting place.

At the earliest streaks of dawn we were awakened by a terrific bombardment of firecrackers from a near-by passing junk. The coolies, I was surprised to see, held the explosives in their hands as they went off, and there was much talk and bickering over it all. Langdon felt certain that "Chinese man catch plenty face" shooting off firecrackers. This craving for face he thought was the cause of the bombardment. After a few minutes' observation, however, I became convinced that the cause was simply an incurable but completely childish passion for noise.

We were on our way again long before sunrise. Jumping off the sampan on a cold misty morning into gurgling muck was far from pleasant. The tide came in so fast that before long we were waist-deep in water. Soon it became advisable to retire to the sampan. Moreover, it was just as well that we stopped hunting, for we were losing most of the birds that

GEESE, GEESE, EVERYWHERE
The whirring of millions of wings filled the air, sounding at one moment like an express train, and the next like some gigantic waterfall

we killed. One incident of our experience will give an idea of the great quantity of geese. We had a rifle along, and, shortly after reaching the sampan, Langdon put up the 500-yard sight and took just one shot out on to a stretch of water that was black with birds. When we reached the spot, lo and behold, a dead gander was lying on the water, with a bullet through it!

After a while the tide dropped a little, and we succeeded in bagging several more geese before we started home. Langdon had never hunted the marshes before, but it was easy to see that if one studied them carefully and took pains over equipment and put up blinds, the shooting there could not be equalled anywhere in the world.

On our way back to Antung night overtook us, and the moon sailed out among billowy clouds. Great lumber rafts came swinging down river in the gloom. These rafts are of giant size—in scale an acre or so. The Chinese build huts and have open fires on board. We passed an almost endless succession of loaded junks with sails set, slowly making their way up or down the river. Sometimes crowds of Chinese were singing roundelays on deck, and as the sound would grow faint in the distance, the elusive beauty of it seemed to slip out of reach on the night wind. We sat listening intently. There was a gentle ripple on the water, and I remember distinctly one junk that sailed right across the path of the reflected moonbeams, with her beautiful square-ribbed sails gracefully swollen in the breeze. The sound of singing came pulsating now faint, now strong, across the water, and it seemed that in that single picture was reflected all the romance of the East.

We reached Antung at midnight, and with bag and baggage over our heads, wandered up through squalid narrow streets till we secured rickshaws. When we arrived at the Consulate, it was doubly guarded by Chinese soldiers. The bandits (Hunghutze) or red-beards had been creating a disturbance in the Chinese quarter—the very section through which we had just come with all our goods and chattels on our heads.

THE CAVE TIGER OF AMOY

The Story of a Hunt for a Man-eating Tiger that Lived in a Rocky Den Back of Amoy

By WILLIAM LORD SMITH

DURING two years of hunting and studying tigers in Asia my most interesting experience was with the cave tigers of Amoy. It is not often that one gets an opportunity to hunt such animals as these in caves, and crawling into a tiger den below the surface of the earth adds a thrill that is entirely lacking when one hunts these animals in the jungle.

In southeastern China the forests passed ages ago, and there remains today a bare, low-lying country studded with bowlder-covered hills. Often these scattered rocks reach enormous size—twenty feet or more in height—and in the caves formed among these huge and tumbled blocks, the tigers live.

Why the tigers remain in such a God-forsaken land it is hard to say, but they are there in goodly numbers. At night they prowl about the country-side, visiting the scattered villages in search of dogs and pigs and human victims. So comparatively easy is it for these powerful beasts to capture and devour the defenseless natives that practically every tiger is a man-eater.

Certain well defined methods of hunting these tigers have been developed by the people of the country, and it was the local method that I adopted. When a tiger has made a kill, one is able to follow his blood trail across country and into the rock tunnels in which he has taken shelter. There, with luck, one is sometimes able to find him in some recess in the rocks from which there is no second opening through which he can escape, and there, by the light of flaring natives torches, one must shoot him from a distance of fifteen or twenty feet. The native hunters are armed with short trident-like spears, and the torches are made of splintered and dried bamboo.

My head man was Taikoff, a most efficient person, even though we had to converse in pidgin English and the few Chinese words that were at my disposal. He was loaned to me by an English friend in whose house he served as cook, but on the trail he proved to be brave, determined, and of tremendous value in handling the natives we hired. He was subtly able to influence the hunters to obey him even against their wills, and he was at least as efficient in extracting money from me.

It was Taikoff who collected the coolies we required, and we started gaily off up country, confident in the belief that we would obtain our tiger in short order. En route we slept in temples, for they are constantly used as stopping places for travelers. Thus a tent was no part of our equipment, and we put up each evening in some little temple or other, sometimes at the feet of a weird god, beneath whose benign or ferocious gaze we calmly went to sleep.

The trip to the tiger country did not take long, and when we reached it we immediately set about exploring cave after cave, although our efforts met with no success. The Chinese round about soon learned why we were there, however, and word began to come to us from various sources, telling us where tigers had been seen, with the result that we moved from village to village in pursuit of rumors rather than of tigers. We tied goats in what appeared to be tiger districts, leaving them to attract the beasts, but we in-

variably returned to find the creatures unharmed. So consistently did this happen that we finally reached the conclusion that the tigers had somehow obtained word concerning us, and had all decamped.

So regular and frequent were our failures that my hunters at last began to comment, and finally began to break out in open meeting. They saw no chance of bakshish under the conditions that prevailed, and were unwilling longer to pursue so unremunerative a course. Taikoff, however, brought all his persuasiveness to bear, and despite their displeasure, they decided to remain.

We hired a Chinese houseboat and rowed the old tub up a near-by river. The two children of the owner of the craft—a boy and a girl—did most of the work, except when I lent them a hand now and then. As a matter of fact I became a great companion of these youngsters, who seemed to expect nothing but hard work. In that they were not disappointed, yet they were always cheerful, and performed their tasks as if they never dreamed of objecting. Our days on the river in the warm March sunshine were delightful, and the varied assortment of coolies, hunters, and river people mingled merrily together.

One night we moored the boat near an old stone bridge, while Taikoff and I went back into the country to a cave which we watched until late in the evening in the hope that a tiger would appear. We hid ourselves among the rocks and kept our eyes on the entrance to the tunnel, hoping against hope to see one of the beasts which,

THE HUNTING PARTY

Coolies, hunters, and river men made a merry company on the old houseboat, while traveling with Doctor Smith up river to the tiger territory. The two children of the owner did most of the rowing, except when Doctor Smith lent them a hand Note the sail made of matting, which is rolled up out of the way when not in use

ON THE MARCH

On the long tramps over country, desolate except for a few squalid villages near the rice fields, coolies solved the problem of transportation. They marched to the sound of their voices chanting in cadence with the rise and fall of their loads fastened to the ends of pliant wooden rods

by now, I had set my heart on obtaining. But watch though we might, no tiger appeared, while the cooing of wild pigeons alone broke the stillness of the solitude. It is lonely business waiting around in the evening for a tiger, and I must admit that I would have given up had it not been that Taikoff was so confident. The result was that we stayed until dark, but despite our patience no tiger came into view, and ultimately we trudged back to the boat, while I began to wonder whether the tigers of the vicinity were realities or were nothing but the figments of Chinese imaginations.

A little farther up the river we parted with our houseboat and its jolly family, the coolies took up their loads again, and with Taikoff in the lead, we turned away from the stream and began a march toward the south. The country was desolate except for a few squalid villages on the lowlands near the rice fields. Massive rocks covered the low hills, and it seemed that cave tigers certainly must dwell hereabouts if they dwelt any place. The wretched people, gaunt from malaria, were a lot of brigands. A fight was going on between two villages, and they wasted more than a little powder on one another, but fortunately their ancient matchlocks did not seem to do any particular damage.

Tigers were plentiful, we were told. The creatures raided the villages constantly, and people were attacked and killed frequently. At night every house was locked tight, which proved that even if the stories of tigers were false, at least the people believed what they told us. We began to take a renewed interest in our hunt, and finally fell in with the headman of the country, who promised to take us to a monastery back in the hills where, he said, there was a never failing supply of tigers. He seemed reliable, so we took his word, and with him to guide us, we made our way, during all of a long

afternoon, into a district wilder than anything we had yet seen.

Big rocks were scattered about everywhere, often being piled up in menacing citadels. Amid these the small monastery was set, surrounded, it seemed, with chaos. Certainly no more fitting place could have been selected as a tiger's stronghold, but it was a curious place for priests to live, especially if tigers were common in the neighborhood. Still, a Buddhist monk has an almost unique disregard for life. His thoughts are fixed on the future, and what is about him seems to matter but little.

"Where is a likely place for tigers?" we asked, and the priests, without hesitation, pointed to a huge mass of rocks four or five hundred yards away. Beneath those rocks was a cave, they told us,—an ideal home for tigers and one that was seldom vacant. But that kind of story was more or less familiar to our ears and I, for one, was not entirely convinced, when, to my amazement, a tiger crawled out of a tunnel at one end of the hill, and crouched upon a rock.

That I was surprised goes without saying, but I was pleased as well, and despite the fact that the crouching animal commanded a full view of the land between us, I decided to take the chance of stalking him with a single hunter as my companion. I looked to my rifle, and we began our advance, but before we had come within range of him he suddenly disappeared. I had hardly expected to get him, of course, but I was disappointed just the same, especially as evening was almost upon us, and we were forced to return to the monastery. Here, after supper, our party packed themselves away for the night, after having picketed two goats near the entrance to the cave.

We were abroad early the next morning, and our first inquiry was concerning the goats. An investigation showed that they had been killed and dragged some

A BUDDHIST TEMPLE

In China the Buddhist temples make good temporary night shelters for the wayfarer—and the altar gods within smile down alike on all races of men—be they yellow or white

TIGER HILLS
Above Chinese paddy fields stretching to the sea arose menacing citadels of rock—where the man-eaters lived

distance up the hill. Now we were forced to explore the cracks and crannies and caves among the rocks, for obviously no tiger would be in the open in broad daylight. The men, consequently, lit their torches, while Taikoff and I, from the very top of the rocks, covered the district pretty thoroughly with our rifles.

For half an hour the search went on, and then a series of shouts warned us that the tiger was on foot. We could see the spears of the hunters pointing down hill, and we scurried and slipped over the rocks in the direction the beast seemed to have taken. I was down between two bowlders when suddenly he bounded by within fifteen feet, although a rock intervened and I did not see him. We found his tracks in the soft earth between the rocks, but a rain came up just then and the men, claiming that the water would put out their torches, refused to continue the hunt. Reluctantly I gave in, and we returned once more to the monastery.

Another tiger came to our hill the following night but left before sunrise, perhaps because he disliked the smell of smoke that lingered in the tunnels the coolies had traversed. However, he left tracks that were plain enough, and we followed them. They took us past the monastery to a patch of gravel-strewn land, where we lost them completely, but like hounds that had lost a scent, the hunters cast about in every direction. For an hour or more they searched, but never another footprint did they find. He, too, had escaped.

Very much disheartened by now, we pushed on. A quarter of a mile from where we had lost the tracks, a ravine barred our way, and into it the men climbed, encouraged. The place was twenty or twenty-five feet deep, the walls were weathered into cracks and little caves, and the floor of the ravine was

strewn with rocks. Into tunnel after tunnel the men thrust their torches, while I, from the edge of the place, kept as careful watch as I could, hoping to be able to see the tiger if he came out.

While I paced up and down the ravine edge, a young hunter shouted for me to join the party below, and Taikoff, who was standing in front of a black-mouthed tunnel, cried out in excited pidgin English that one of the boys had located a big tiger inside, and that the creature was crouched behind three human skeletons. Taikoff was apparently as happy as a boy just let out of school, for, he claimed, the tiger was as good as dead.

I was far less certain than he seemed to be, but everything was set for a good show, so I slid down the ravine wall, and approached the tunnel mouth. We had the ferocious beast penned in at last, but the cavern mouth was narrow, and there was some difficulty to be faced in approaching him merely by the light of a few flaring bamboo torches. No sooner had we reached the nook in which he had taken refuge than he squeezed through a narrow crack behind him, clawed his way to daylight, and was free again.

We ran back into the ravine, wondering just which direction the animal had taken. He, however, had no intention of running. Evidently angered by our invasion, he determined to make a stand and there, seventy-five yards away, he stood growling in the open, his tail threshing back and forth, his teeth bared. I took a deep breath and raised my rifle. For a moment I aimed, and pressed the trigger, but there was no report. I looked quickly and saw that the safety lever was on, but before I could switch it off, the tiger, with

THE TIGER'S STRONGHOLD

Never was such a hunting ground in which to play hide and seek with a tiger. While the men drove the tiger through caves and tunnels Doctor Smith and his head man tried to cover all avenues of escape with their rifles

a parting growl, leaped away, while I, with a snap shot, managed merely to cut the flesh of his right hind leg.

Past the monastery he galloped, and up to the hill of rocks where he had passed the night, and we, pell mell, followed after. We slowed up on reaching the hill, however, for the tiger might be waiting for us behind any one of the big rocks. We located his tracks in one spot, and promptly climbed to the top of the hill, keeping a sharp lookout us as we struggled upward.

By this time the Chinese of the whole country-side had joined the hunt. There were scores of them—hundreds, perhaps. They swarmed over the hill, jumping from rock to rock, shouting joyfully to one another, and were apparently entirely indifferent to the fact that a really dangerous animal was at large, and might, at any moment, leap upon someone. It was exasperating for me, but obviously it was great fun for the Chinese, though the hunt was plainly ruined.

The tiger—new to such a proceeding—suddenly appeared. A hunter pointed out his head to me, down a tunnel. For a moment the beast shrank back, and then, gathering confidence, rushed toward us with a tremendous roar. Several hunters, far more courageous than one might imagine possible, dashed toward the creature with their short spears held before them. Roars from the tiger and cries from the men filled the air. It was a splendid sight, this clash of primitive forces in man and beast. The men thrust with their spears. The tiger, growling deeply, spat at them. A spear was thrust into his very jaws and he shrank back in pain,

VANQUISHED

The native hunters, armed only with their tridents, unhesitatingly entered the caves among the bowlders, thrusting flaring torches of bamboo before them. By this method they located the tiger and drove him out

A VICTORIOUS PROCESSION

When the magnificent beast was finally killed by a bullet from Doctor Smith's rifle, the entire concourse of Chinese crowded about—those who had until then treated the hunt as a joke being the most eager to carry the booty back to headquarters. The animal tipped the scales at 385 pounds

and astonished, no doubt, at the attack. For a moment he tried to stand his ground, but the odds were too great. He snarled savagely and, as the hunters shouted and advanced, the tiger suddenly leaped away, disappearing once more among the rocks.

The hunters shouted louder than ever, rehearsing the whole scene. They struck the air madly with their spears, crying at the tops of their voices and trying, now and again, to imitate the deep, throaty growl of the animal. All about was bedlam, but Taikoff sat down as calmly as if he were at a picnic—an attitude that I could not imitate. For some time he waited patiently for the men to cool down. Little by little they did, and Taikoff began talking with them quietly. At first they refused to go farther with the hunt, but somehow, with the persuasiveness that was his, Taikoff gained his point. After much talking, which was meaningless to me, they picked up their torches, lit them once more, and with their spears held before them, slid down into the hole in the rocks into which the tiger had disappeared. I watched them until the blackness swallowed them up, and then, with Taikoff, I began circling the hill so as to keep informed of any operations that might take place above ground.

We were now completely out of touch with the hunters. Where was the tiger leading them? Filled with fear of the torches, the beast, no doubt, was gliding noiselessly through the dark labyrinths of his home, with the men in hot pursuit. A flash of orange and black caught my eye between two rocks. It was gone the instant it appeared, yet obviously it was the tiger. There was not a sign of the hunters. Even the villagers were not in that immediate vicinity. Only dull gray rocks lay tumbled all about, and deep between two of them the tiger had momentarily appeared. I wondered what I should do next, but before I had

ARE THESE TIGERS LOSING THEIR STRIPES ?

It is supposed that the tiger originally came from northern Asia, where the most successful coloration was one made up of long dark stripes to imitated the shadows of the trees in the districts be inhabited. The Chinese tiger of today has a broken coloration of short black dashes and rosettes which imitate well the shadows among the bowlders where he lives

decided, a deep roar came from the rocks behind which the beast had disappeared, and almost before the roar was ended the tiger leaped into sight.

This time I was ready. My sights caught his head and I pulled the trigger, while the crack of the rifle was hardly to be heard above the reverberations of another roar. The beast stopped short in his stride. His muscles gave way and he fell on his side. He quivered for a moment and I caught the movement of muscles beneath the flame-colored skin. For a second the whole body remained tense, and then relaxed. The handsome animal lay dead.

The whole concourse of Chinese crowded about while I took some photographs. Then we weighed him. The balance stopped at exactly 385 pounds, a goodly weight. As we stripped off the skin, the Chinese begged for the tiger's blood to drink and his flesh to eat, for according to Chinese belief, there would thus pass into them the strength and courage of their foe.

Now that we had secured our tiger, we quickly packed up our outfit and started for the river, whence we sailed for Amoy.

THE INTERNATIONAL CONGRESS OF AMERICANISTS

A Scientific Body Especially Concerned with the Study of the Aboriginal Population of the New World, that Will Hold Its XXIII Session at the American Museum of Natural History in September

By CLARK WISSLER
Curator-in-Chief, Division of Anthropology, American Museum

WHEN Columbus returned to Spain with the startling information that across the Atlantic were new and strange peoples, the scholars of Europe found themselves face to face with a number of perplexing problems. The Indians, as the native inhabitants of these newly discovered lands came to be called, spoke in strange tongues and bore little resemblance to any other known people. Ever since that time many scholars in Europe and later in America, have gathered information on the languages, modes of life, and the past of these unique native peoples.

The first serious students of Indian life were the Catholic and Protestant missionaries to the Indians, many of them the most scholarly men of their generation, and it is to the most learned of these that we owe the first reliable records of native languages, the exact location and number of living tribes, etc.

One of the great questions challenging the scholarship of the time was to discover in what way these Indians were related to the races of the Old World, and how and when their ancestors reached America. These questions still puzzle the scholars of Europe and America, but in the meantime a great deal has been learned about these natives, and archæologists have been able to recover some of their history, so that the answer to these fundamental questions may be forthcoming in the near future.

As we have said, the scholars of Europe were, from the first, greatly interested in the American Indian, and so quite naturally, it came about that in 1875 an international society was organized to promote research in this field. The first meeting of the society, now called The International Congress of Americanists, was held at Nancy, France. Its purposes, as stated, are to contribute to the progress of the ethnological, linguistic, and historic studies related to the two Americas, especially in regard to the period before the time of Columbus.

At a meeting in Paris in 1900, the subjects for study were reaffirmed as follows:

(1) The races of America and their relationship to other peoples.

(2) The archæological remains found in America, and time relations as revealed by them.

(3) The habits and customs of the various groups of American Indians, and questions of the origin and distribution of these in the Old and New Worlds.

(4) The native languages of America.

(5) The early history of America, especially in regard to its discovery and early settlement.

(6) Geographical and geological questions, especially as related to prehistoric human activities.

For about twenty-five years after its founding, the meetings of the Congress were held in Europe, gathering successively in the capitals of the leading nations, but in 1900 this policy was changed, and it was decided to hold each alternate meeting in the New World. Since that time the Congress has met in Mexi[illegible]

South America, Canada, and the United States. In 1902 the Congress met in the American Museum, and Morris K. Jesup, then president of the Museum, was its Honorary President, so designated in recognition of his generosity in supporting extensive researches in all lines of anthropology. The only other session of the Congress in the United States was held in Washington, D. C., in 1915.

Unlike many other scientific bodies, the Congress of Americanists is looked upon as under governmental auspices. Thus, it is usual for the executive head of the country in which it is held to act as the patron of the Congress. What logically follows is that invitations are sent through diplomatic channels, asking that the respective governments each designate and send official delegates to represent them at the Congress. For example, when the Congress met in Washington, D. C., in 1915, President Woodrow Wilson was the patron and the late Hon. John W. Foster presided. The character of the patronage and the presence of delegates representing the governments of Europe and North and South America, add special dignity to the proceedings.

President Henry Fairfield Osborn of the American Museum is the Honorary President of the XXIII Session of the Congress, to meet at the Museum during the week beginning September 17. The sessions are, however, under the joint auspices of the American Museum of Natural History, Columbia University, the Brooklyn Museum, the Museum of the American Indian (Heye Foundation), the American Ethnological Society, the American Geographical Society, the New York Academy of Sciences, and the Archæological Institute of America.

The headquarters will be at the American Museum of Natural History, but meetings will also be held at Columbia University, the Museum of the American Indian (Heye Foundation), and the Brooklyn Museum. A large number of distinguished scholars are expected, among them Baron Erland Nordenskiold, who has devoted years to research in South America; Captain Thomas A. Joyce of the British Museum; Mr. Lewis C. G. Clarke of the Museum of the University of Cambridge, England; Professor Louis Capitan of France; Professor William Thalbitzer of Copenhagen, an authority on the language of the Eskimo; Professor Kaj Birket-Smith, who will report the results of the Thule Expedition led by R. Rasmussen; Hofrat Franz Heger of Vienna; Father Koppers, editor of *Anthropos;* and Professor G. V. Callegari of Verona, secretary of the XXII Session of the Congress.

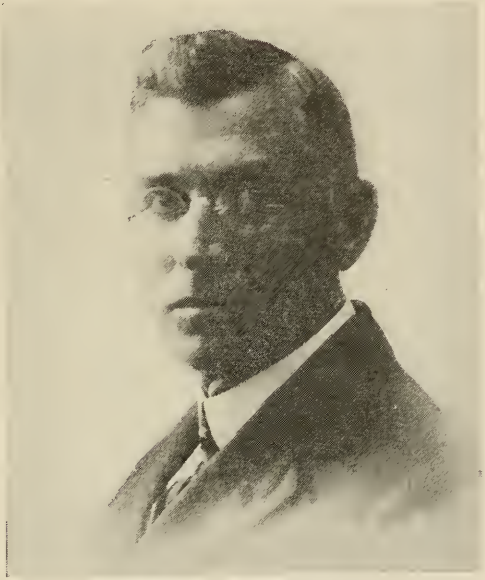
From South America, Doctor Jose Toribio Medina will represent Chile; Professor Julio Tello is a delegate from Peru. Dr. Salvador Debenedetti and Dr. Felix Outes are expected from Buenos Aires; Dr. Manuel de Oliveira Lima of Washington is to represent Brazilian institutions; and the Minister of Education of Mexico, Dr. Manuel Puig y Casauranc, will head the delegation from Mexico.

PLINY EARLE GODDARD
1869-1928

By N. C. NELSON
Curator of Prehistoric Archæology, American Museum

THROUGH the sudden death, on July 12, of Pliny Earle Goddard, curator of ethnology since 1909, the American Museum sustains the loss of an able and energetic staff member.

Doctor Goddard was born of Quaker parentage on August 24, 1869, at Lewiston, Maine. In Maine also he spent his boyhood and received most of his preparatory schooling which, however, was completed at Union Springs in New York State. He was graduated from Earlham College, Richmond, Indiana, receiving his A.B. and A. M. degrees respectively in 1892 and 1896, doing some teaching in the interval. Shortly afterward he accepted service as missionary to the Hupa Indians of Humboldt County, California. Three years later, or in 1899, he entered the University of California, where he obtained his Ph.D. degree in 1904, having served in the meantime as instructor. In 1906 he was appointed assistant professor, a rank which he held until 1909, when he joined the American Museum staff as assistant curator.



DR. PLINY E. GODDARD
Curator of Ethnology, in the American Museum of Natural History

These are mere stepping stones in a man's life and we have time to examine the moss on only the last two of them. Doctor Goddard's specialty was Indian languages, and he devoted himself almost exclusively to the study of the dialects of the great Athapascan family scattered from Alaska to Mexico, including such tribal groups as the Hupa, the Navaho, and the Apache. As a result, seventeen professional papers of more or less extensive and monographic character are credited to him, ten of them among the University of California Publications in American Archæology and Ethnology, and the remainder on the list of the *Anthropological Papers* of the American Museum of Natural History. These major publications include linguistic texts, with translations, derived from the Hupa, Kato, Chilula, Sarsi, Chipewyan, Beaver, and Jicarilla Apache Indians. There are also several phonological and morphological expositions and, lastly, some three or four descriptive papers relating to social and material aspects of Indian culture. His first and perhaps his most readable paper, which was also the initial publication of the University of California series, is entitled "Life and Culture of the Hupa."

After coming to this institution Doctor Goddard naturally gave a large share of his time to Museum problems and thus gradually all but lost contact with his

linguistic interests. Museum activities, in other words, compelled him to broaden out. In this new field he planned and arranged several of our North American halls, especially those exhibiting the arid Southwest and the Northwest Coast cultures. In later years he also revised the Asiatic Hall. He supervised the execution of three unrivaled habitat groups in the Southwest Hall and likewise several murals in the other halls. To complete his installation work he produced two model *Handbooks* giving the necessary background to explain the exhibits respectively in the Southwest Hall and the Northwest Coast Hall.

In addition to these major activities Doctor Goddard took part in many other lines of endeavor. Thus he made numerous and fairly strenuous field trips to the western states and to distant parts of northwestern Canada, besides other journeys to Peru, to Mexico, and to Europe. He was editor for several years of the *American Anthropologist;* he served various of our national and local organizations in different capacities; and during the last ten years or so he gave formal instruction to a large number of Columbia and Barnard students. Perhaps it is not out of place to add that he acted of late years as secretary to the meetings of the Museum's scientific staff. Besides all these professional labors, he found time to run a small greenhouse and to take a vital part in civic and community affairs at Leonia, New Jersey, where he lived. His last considerable undertaking was the secretaryship of the coming International Congress of Americanists in September, which will be seriously handicapped by his untimely death.

Such are some of the bare facts of the useful and interesting career of a man of distinctly high scientific ideals—a career well deserving of more comment than can be given in this place. But over and above all this rises Doctor Goddard's rugged strength of character, and withal his jovial—almost sprightly—personality. He had something of the nature of flint in his make-up and it was easily possible to draw fire from him; but it was only a flash and not a smoldering conflagration. He was fond of his children, five of whom—with his wife—survive him. He was intensely loyal to his friends and not at all averse to fighting his enemies. Finally, whether he realized the insidious character of his malady or not, he was ever a boy at heart, a good sport, and a first-rate camp fellow. Surely a man who passed so easily these last tests is in no need of further tribute.

NOTES

CENTRAL ASIATIC EXPEDITION

Dr. Roy Chapman Andrews reports most satisfactory progress in the following letter just received by the American Museum:

In Camp, Shara Murun, May 3, 1928

We are in the midst of our daily sandstorm and the dust drifts in so thickly upon my paper that it is difficult to write. We have been here for 12 days and never have I seen such infernal weather in Mongolia. Every day such terrific sand gales that we only sit in the tents while a yellow cloud swirls about us. Everything is a mass of sand—guns, cameras, beds—we are simply smothered in it. Nevertheless we have managed to put in some hours working and in spite of the storms have discovered some good things. Mac Young found a remarkable titanothere skull, quite unlike anything Granger or Thomson know. A river bed deposit has proved to be a rich quarry and bird bones, carnivore skulls, and many other things are plentiful.

We got through the brigand area without trouble. We spent one day near Tserin's place while I visited a Mongol prince, Sunnit Wang, in whose province I want to pasture our camels next winter. Then we came straight here. The caravan of 125 camels arrived on the same day that we did.

After getting the party at work I made a five day exploration westward to find a suitable trail for the caravan to follow. Then I returned and got the camels started two days ago (May 1st). They will go on as fast as possible and we will overtake them. We'll spend another 10 days in this region and then start west. In the mean-

time I expect to explore the country between here and Iren Dabassu and will leave this letter at the telegraph station hoping someone will take it out.

A short exploration toward Iren Dabassu has shown that there are great areas of beautifully exposed sediments and that they contain rich deposits of fossils. Probably there is enough for an entire season's work. We will stop here again this September and work more but I want to get started westward soon.

We are earlier in the field than in any previous year. Thus far, all my plans have gone like clockwork. I laid out the whole program for getting away last January and the machinery moved exactly to specifications. We were very fortunate in every way.

The camels are in fine condition—Tserin, I have made the caravan leader. All the staff is keen and we have a happy family in camp. This fortnight has been *very* trying because of the continual sand storms but they have stood it well. I know of few things more nerve-wracking. However all of us will be glad to start west. The deposits here are very rich indeed and we feel quite sure that they will warrant a party working here all next summer. We will almost certainly leave some men here.

This quarry is particularly important because apparently it gives a complete exhibit of the fauna of the region. Rodents, insectivores and other small things are as well preserved as are the larger specimens. A fine premolar tooth of *Andrewsarchus* has turned up, femur of Eudinoceras, also canine tooth of same. I am hoping we will get some Primate stuff before the quarry is exhausted. There seem to be weeks of work in it still waiting to be done. We'll have another go at it in September.

You will not hear from us again till about September.

The letter concludes with an account of the injury suffered by Doctor Andrews through the accidental discharge of his revolver while attempting to shoot an antelope, and of the very skillful and successful treatment of a serious wound in the thigh by the surgeon of the party, Doctor Perez, under most difficult circumstances, when dust storms penetrated the hospital tent and covered every object in the camp.

STOLL-McCRACKEN EXPEDITION

The Stoll-McCracken Arctic Expedition cables that it has been successful in obtaining a g od series of specimens of the giant brown bear of Alaska, one individual being of especially large size. Some of these specimens will be used in the preparation of a habitat group for the American Museum.

FISHES

Fishes from the White Nile.—A collection of fresh-water fishes from the Nile obtained by the Taylor Sudan Expedition of 1927, fill a gap in the Museum's extensive series of African material. A short report on them in *Novitates* is accompanied by general discussion of the fresh-water fish faunæ of Africa. There are there two clearly marked faunæ. One, the most typically southern, occupies the Nile, Congo, and West Africa in general; the other, with more affinity to that of the Indian region, occupies East and South Africa.

The continental fresh-water fishes of the world may be divided into two main faunæ, those of the northern continents contrasting with those in Africa and South America, which have much in common. In the main, however, they seem to have entered the two southern continents from the north, independently, and at about the same period.—J. T. Nichols.

HISTORY OF THE EARTH

In an article "Volcanoes in Action" by Chester A. Reeds in the May–June number of Natural History, it was stated that the next eruption of the volcano Mayon in the Philippine Islands would in all probability be exceptionally violent. Two months after this forecast was made, an Associated Press dispatch from Legassi, P.I. dated July 1, was received in New York, which stated that the volcano had been in violent eruption since June 21, that the coast town of Libog with a population of 7000, and several villages near the eastern base of the volcano had been virtually destroyed by lava flowing from the volcano, and that two army aviators, Lieutenants George W. Goddard and John D. Corkville, who flew over the crater June 30, reported that the crater was about 400 feet in diameter, and was filled with molten lava.

Some accounts give the height of the graceful cone of the volcano as 7916 feet, others as 8274 feet, and 120 miles in circumference at its base, which is surrounded by an extensive plain. The volcano is only six miles distant from the eastern shore of Albay Province, in southern Luzon, the largest of the Philippine Islands.

The volcano has erupted frequently since 1616, the date of the first recorded outburst. There were 26 eruptions during the Nineteenth Century, those of February 1, 1814, and June 25, 1897, being of great violence. The last outburst previous to the June, 1928, eruption, was in March, 1900, and it was chiefly upon the length of the quiescent period, 1900–1928, and our present knowledge of volcanic activity, especially of Vesuvius, that the violent nature of the June eruption of Mayon was predicted.—C. A. Reeds.

Dr. Robert Broom, of South Africa, has just arrived in New York on a two months' visit to the American Museum. He has brought with him a few very interesting South African fossil reptiles. The most important of these specimens

is a practically complete skeleton of a Gorgonopsian reptile. The Gorgonopsia are particularly interesting because they are very near to the ancestors of the mammals. Heretofore we have known only one skeleton, which is in Russia, and that is not very perfect, the feet being lost, and the bones being in a rather unsatisfactory condition. This new South African skeleton reveals all details of the structure of both the anterior and posterior limbs. It also shows that the Gorgonopsia had an ossified breast bone. Doctor Broom hopes, while in New York, to make a further study of the specimens of the South African reptiles in the Broom collection, which was acquired by the Museum fourteen years ago, in view of a monograph which he hopes to publish on the South African fossil reptiles.

We regret that Doctor Broom has been suffering from bronchitis and asthma during the past year, and he feels that he will not be able to stand the winter climate in New York, otherwise he would be only too pleased to make his visit longer.

It is fourteen years since Doctor Broom was last with us, and he says he is greatly struck with the marvelous advances the Museum has made in this time. He is especially interested in the wonderful finds that have been made in Mongolia.

A Recent Press Article of the Carnegie Institution is devoted to the Unique Language of the Trees, dealing with the records of climate as translated by Andrew E. Douglass and Ellsworth Huntington from a study of their rings of yearly growth, and suggesting that the records may be extended to include Sun Spot Cycles.

The information as to periods of abundant or scanty rainfall conveyed by the yearly rings of the Big Trees compares very closely with that obtained by Baron de Geer and his students from a study of the clay deposits (varves) made in past times by rivers here and in Europe.[1] The principal illustration in the article is of the section of the Big Tree in the American Museum, bearing a record of a few of the notable events that happened during the tree's lifetime. How much happened will be given in more detail on the chronological labels now being prepared in accordance with a request of President Osborn.

MAMMALS

Additions to the Vernay-Faunthorpe Collection.—Mr. A. Dunbar Brander, formerly Conservator of Forests in India, and author of *Wild Animals in Central India* has recently made a very interesting addition to the proposed Asiatic Hall of the American Museum of Natural History—namely, a good specimen of the very rare four-horned antelope (*Tetraceros quadricornis*). Colonel J. C. Faunthorpe contributed a pair of specimens a year or two ago. In connection with this valuable gift, Colonel Faunthorpe writes (June 14, 1928):

I have now obtained a good specimen which has all four horns developed, and am shortly sending this out, together with the skeleton and measurements, also two skulls illustrating the other types of head. (These are a gift of Mr. A. Dunbar Brander.) You may remember that a year or two ago we sent you a pair of four-horned antelope (*Tetraceros quadricornis*) specimens. The male specimen, as frequently happens, had not the front horns developed, these being merely indicated by lumps of bone under the skin. It is an interesting fact that in this species about thirty per cent of the males have four distinct horns, another thirty per cent have the back horns fully developed, the front horns merely consisting of little knobs coming through the skin, while the remainder have no front horns at all, but merely small protuberances in the bone of the skull, which are completely covered by skin and hair. It may be that the tendency in this species is to lose the front horns altogether. This no doubt would take a very long time to become complete.

The Museum has greatly desired to secure a still more rare, nearly extinct species in India—namely, the Asiatic lion (*Felis leo goojratensis*) and the necessary permission has been obtained. Regarding this, Colonel Faunthorpe writes:

. . . . it was a great disappointment to me that I fell ill and could not go to Kathiawar after it in March. Unless the local potentate changes his mind, I hope to be able to obtain this very rare specimen next winter.

SCIENCE OF MAN

Children Running on All Fours.—Dr. Aleš Hrdlička, who has recently published a series of observations on "children running on all fours" for a shorter or longer time before walking, says in the *American Journal of Physical Anthropology*, Vol. XI, No. 2. "There is no doubt any more but that we are facing here a phenomenon of no mean order."

Doctor Hrdlička discusses additional and exceedingly interesting reports, which he sums up under the following Résumé:

With the much larger number of cases at our disposal and the more circumstantial reports in many of these, it seems possible now to formulate some fairly definite views regarding the phenomenon here dealth with. These are:

1. The human infant, in probably all races and of both sexes, develops in more or less infrequent instances, instead of crawling, the peculiarity of running effectively and with facility on all fours.
2. The manifestation replaces that of crawling, mostly completely, sometimes partially, and tends to end when walking commences, but in numerous cases is indulged in irregularly for shorter or longer periods thereafter. The child prefers and enjoys the performance.
3. The children showing the peculiarity are, as a rule, healthy, strong, active, and, in general, above rather than below the average. There is no indication that the tendency is associated with any either constitutional or acquired weakness or defect.
4. The determining causes of the manifestation lie evidently in the child's conformation at this period and in the desire of the healthy and strong child to get about more quickly than by crawling; the basic cause, however, is apparently of atavistic nature, the whole phenomenon being thus one of the order of functional reminiscences of an ancestral condition.
5. Direct heredity plays, it seems, but a secondary rôle in these cases; but the subject needs a thorough further inquiry.
6. Some of the children that run on all fours show sooner or later other functional or somatic peculiarities which deserve scientific attention.

[1] See the article "Baron de Geer and His Work" by James F. Kemp in Natural History for 1921, pp. 31–33.

MEETINGS OF SOCIETIES

THE GENEVA CONFERENCE FOR BIRD PRESERVATION.—A notable gathering for the preservation of wild life took place in Geneva, Switzerland, in May, 1928. This was the third biennial meeting of the International Committee of Bird Preservation, a movement originating in London in June, 1922, under the leadership of Dr. T. Gilbert Pearson, who with Lord Edward Gray, Lord Buxton, M. Delacour, Mr. Van Tienhoven and other prominent Europeans met in the home of Reginald McKenna for this purpose. National sections of the committee composed of official representatives of leading scientific societies, museums, and conservation organizations are now in operation in twenty countries.

At the Geneva meeting definite plans were laid for legislation and international treaties which it is believed will have beneficial effects on preserving the persecuted bird life of the world. The resolutions and other propositions of the International Committee will be laid before the assembly of the League of Nations at its meeting in September this year. The Committee has engaged an active European secretary in the person of Dr. J. M. Derscheid of Brussels. A series of lectures will be organized in France in the beginning of autumn and a wide publicity campaign in the press of Italy has been determined upon. The publication of literature and its distribution in the schools of Hungary will soon begin. The expenses of this international movement for bird protection thus far have been borne by the National Association of Audubon Societies of which Doctor Pearson is president.

NEW PUBLICATIONS

The newest addition to the splendid series of Putnam's field books is the *Field Book of North American Mammals*, by H. E. Anthony (xxvi–625, 32 color plates, 16 photographic plates, 119 text figures, 40 maps in text, 1 folded life-zone map). 1928. G. P. Putnam's Sons. New York.

This book by the American Museum's curator of mammals is the first and only complete guide to the mammals north of Mexico; in it all the 1445 forms are named. The data accompanying each has of necessity been brief, though included for each subspecies are the common and the scientific names, a description of the pelage, measurements and range. The book, being primarily designed for laymen, depends chiefly on external characters and range maps supplemented by numerous illustrations for the identifications. For each species or group of closely related forms whose habits are similar, there is given a general account of the habits and most salient relations. Often the chief habitats are described. The book will enable anyone with "good eyes and ears and a fair amount of patience" to name the animal in question. In addition, enough of interest concerning the species may be had to fix it well in one's memory. The book, being but $4\frac{1}{2}\times7\times1$ inches, fits well within one's pocket.—R. T. H.

Fur Farming for Profit, the MacMillan Company, by Frank G. Ashbrook, combines the information and experience gained by the author, through many years' connection with the Biological Survey at Washington. As Mr. Ashbrook says, the breeding of fur animals is still in its infancy, yet it is now a healthy infant, and this book will fill a growing demand for information in regard to it.

Naturally a large portion of the book is devoted to the silver fox, since, owing to the high prices brought by its fur, success in raising it brings large returns. For many years the great profits lay in raising and selling foxes for breeding purposes, and very few pelts appeared in the annual sales; but this has now changed. The number of skins from fox farms has steadily increased, and in 1925 one Wisconsin company alone sold over 4000 skins.

Following the foxes, the more familiar fur-bearing animals are treated, including even the fisher and beaver—particular attention being given to the muskrat, which has become practically our most important fur-bearer and the one most widely distributed and most readily utilized.

The habits of each animal are dealt with. Then follow directions for selecting a ranch site, and instructions as to the care and management of the captive animals. Above all, emphasis is laid upon the need of care if the would-be fur farmer wishes to be successful; care in the selection of the locality of a fur farm, care in the selection of the breeding stock and in handling it, and finally care in the preparation of pelts for market.

Besides the native wild fur-bearers, the domesticated rabbit is dwelt on at some length, as well as the two foreigners, the pretty little chinchilla and the karacul sheep.

All in all, this book will satisfactorily answer the inquiries that have from time to time been made of the library for information in regard to fur farming.—F. A. LUCAS.

THE FOLLOWING PAPERS have been published in *Novitates* and the *Bulletin*, during the period from January 12 to June 23, 1928.

Novitates

No. 293. New Birds from Mexico and Panama. By Ludlow Griscom. 6 pp. January 12, 1928.

No. 294. The Smallest Known Specimens of the Sucking-fishes, *Remora brachyptera* and *Rhombochirus osteochir*. By E. W. Gudger. 5 pp. Two text figures. January 28, 1928.

No. 295. The Systematic Position of the Phallostethid Fishes, with Diagnosis of a New Genus from Siam. By George S. Myers. 12 pp. Two text figures. February 1, 1928.

No. 296. A New Melanotæniin Fish from Queensland. By J. T. Nichols and H. C. Raven. 2 pp. One text figure. February 1, 1928.

No. 297. A New Mammalian Fauna from the Fort Union of Southern Montana. By George Gaylord Simpson. 15 pp. Fourteen text figures. February 2, 1928.

No. 298. Stones of Celtis in the Tertiary of the Western United States. By Edward W. Berry. 5 pp. Six text figures. February 3, 1928.

No. 299. Odors and Insects. By F. W. Brown. 9 pp. February 10, 1928.

No. 300. Carpenter Bees of the Genus *Mesotrichia* Obtained by the American Museum Congo Expedition, 1909–1915. By Norma LeVeque. 23 pp. Twenty-nine text figures. February 21, 1928.

No. 301. Bones of Birds from the Ciego Montero Deposit of Cuba. By Alexander Wetmore. 5 pp. Two text figures. February 29, 1928.

No. 302. Additional Specimens of Fossil Birds from the Upper Tertiary Deposits of Nebraska. By Alexander Wetmore. 5 pp. Two text figures. February 29, 1928.

No. 303. Two New Fossil Amphibia of Zöogeographic Importance from the Miocene of Europe. By G. K. Noble. 13 pp. Six text figures. March 21, 1928.

No. 304. Enzymes and Bacteria in the Honey Bee. By F. Martin Brown. 5 pp. March 29, 1928.

No. 305. A New Species of Bacteria and the Gall of an Aphid. By Frank E. Lutz and F. Martin Brown. 4 pp. March 29, 1928.

No. 306. Some Plethodontid Salamanders from North Carolina and Kentucky with the Description of a New Race of *Leurognathus*. By Clifford H. Pope. 19 pp. One text figure. April 14, 1928.

No. 307. American Eocene Didelphids. By George Gaylord Simpson. 7 pp. Five text figures. April 14, 1928.

No. 308. A New Species of Waxbill (*Estrilda*) from the Southeastern Congo. By James P. Chapin. 3 pp. One text figure. April 24, 1928.

No. 309. A New Fishes from the Southeast Corner of the Congo Basin. By J. T. Nichols. 4 pp. Three text figures. April 24, 1928.

No. 310. A Mackerel (*Scomber scombrus*) with a Rubber Band Rove Through Its Body. By E. W. Gudger. 6 pp. Three text figures. April 24, 1928.

No. 311. The Histological Nature of Ossified Tendons Found in Dinosaurs. By Roy L. Moodie. 15 pp. Six text figures. April 25, 1928.

No. 312. Multituberculates in the Wasatch Formation. By Walter Granger and George Gaylord Simpson. 4 pp. Two text figures. May 14, 1928.

No. 313. The African Cuckoos of the Genus *Cercococcyx*. By James P. Chapin. 11 pp. One map. May 16, 1928.

No. 314. New Central American Snakes in the American Museum of Natural History. By Emmett Reid Dunn. 4 pp. May 16, 1928.

No. 315. Results of the Douglas Burden Expedition to the Island of Komodo. IV. Frogs from the East Indies. By Emmett Reid Dunn. 9 pp. May 18, 1928.

No. 316. Results of the Douglas Burden Expedition to the Island of Komodo. V. Observations on the Habits and Distribution of *Varanus komodoensis* Ouwens. By William Douglas Burden. 10 pp. One text figure. May 18, 1928.

No. 317. New Asiatic Mammals. By Glover M. Allen. 5 pp. May 19, 1928.

No. 318. The Whale Shark, *Rhineodon typus*, Near Havana Harbor, Cuba. The Fifth Record from the Straits of Florida. By E. W. Gudger and W. H. Hoffmann. 7 pp. Three text figures. June 5, 1928.

No. 319. Fishes from the White Nile Collected by the Taylor Expedition of 1927. A Discussion of the Fresh-water Fish Faunæ of Africa. By J. T. Nichols. 7 pp. June 23, 1928.

No. 320. Seven New Reptiles from Fukien Province. China. By C. H. Pope. 6 pp. June 23, 1928.

Bulletin

Bulletin LVII, Art. V. An Ornithological Survey of the Serra do Itatiaya, Brazil. By Ernest G. Holt. 76 pp. Plates VI to XIX. June 7, 1928.

Art. VI. Diptera of the American Museum Congo Expedition. By C. H. Curran. 73 pp. Seven text figures. June 9, 1928.

REPTILES AND AMPHIBIANS

Central Asiatic Reptiles.—Mr. Clifford Pope has returned from a trip to Chicago where, with Mr. Karl P. Schmidt of the Field Museum, he spent ten days studying his last collection of reptiles made for the Central Asiatic Expedition in China. The collection includes about 2600 specimens, among which are representatives of more than ninety species, nearly all of which are from Fukien Province. The previous collections of reptiles and amphibians made by the Central Asiatic Expeditions have been reported by Mr. Schmidt. Mr. Pope's complete report, which will appear in a subsequent *Bulletin*, will include all of the American Museum's Chinese reptiles not already reported on. Twelve new forms have been described by Mr. Pope in recent *Novitates*.

THE ALBERT OPERTI LOAN EXHIBITION OF PAINTINGS

During the three weeks beginning June 15 there has been displayed in Education Hall a a loan series of 52 paintings and sketches by the late Albert Operti, arctic and marine painter. These were loaned through the courtesy of a number of his friends, mostly members of the American Museum staff.

The exhibition represented a cross section of Mr. Operti's work rather than a collection of his more important paintings, such as hang in the Capitol at Washington. Examples of these latter are not lacking, however, since the two large canvases of whaling scenes belong in this category.

The collection of sketches was particularly rich in views of arctic scenery and of shipping at sea, which comprised the artist's most characteristic field, if one may say that such a versatile painter had a characteristic field. The exhibition also showed some representative examples of Mr. Operti's glimpses of oriental life, executed in vivid color, many of which were painted from memory. In a prominent position was a bust of Mr. Operti, the work of Mr. N. J. Burns. The paintings and sketches were loaned by Doctors Reeds and Miner, and Messrs. Arogast, Beers, Conolly, Dill, Faunce, Klassen, Meyenberg, Mueller, Olsen. Pindar, Quinn, Short, Siebert, Southwick, Whitlock, and Miss Callahan.

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AUTUMN AND SPRING COURSES OF POPULAR LECTURES

Series of illustrated lectures, held in the Auditorium of the Museum on alternate Thursday evenings in the fall and spring of the year, are open only to members and to those holding tickets given them by members.

Illustrated stories for the children of members are presented on alternate Saturday mornings in the fall and in the spring.

MEMBERS' CLUB ROOM AND GUIDE SERVICE

A room on the third floor of the Museum, equipped with every convenience for rest, reading, and correspondence, is set apart during Museum hours for the exclusive use of members. When visiting the Museum, members are also privileged to avail themselves of the services of an instructor for guidance.

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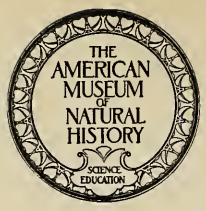

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EXPLORATION

FIFTY-EIGHT years of public and scientific service have won for the American Museum of Natural History a position of recognized importance in the educational and scientific life of the nation and in the progress of civilization throughout the world. With every passing year the influence of the Museum widens, as is witnessed by the increasing number of visitors who daily enter its halls. Nearly two and a half million persons visited the Museum for study and recreation during 1927, an increase of 15 per cent over the preceding year, and all of these had access to the exhibition halls without the pay ment of any admission fee whatever.

The Museum's service to the schools has been greatly increased by the opening, last year, of the new School Service Building. Ten million contacts were made during 1927 with boys and girls in the public schools of New York and the vicinity alone. Inquiries from all over the United States, and even from many foreign countries are constantly coming to the School Service Department. Information is supplied to, and thousands of lantern slides are prepared at cost for distant educational institutions, and the American Museum, because of this and other phases of its work, can properly be considered not a local, but a national—even an international—institution. Through its loan collections, or "traveling museums," which are circulated locally, 495 schools were reached last year, and 1,722,433 pupils were directly reached. Nearly a million lantern slides were lent to the New York City schools, and 3,301 reels of the Museum's motion pictures were shown in 122 public schools and other educational institutions in Greater New York, reaching 1,123,704 children.

Lecture courses, some exclusively for members of the Museum and their children, and others for schools, colleges, and the general public, are delivered both at the Museum and at outside educational institutions.

For those interested in scientific research or study on natural history subjects, the Library, containing 115,000 volumes, is available, and for the accommodation of those who wish to use this storehouse of knowledge, an attractive reading room is provided.

Many publications, both popular and scientific, come from the Museum Press, which is housed within the Museum itself. In addition to NATURAL HISTORY, the journal of the Museum, the popular publications include many handbooks, which deal with subjects illustrated by the collections, and guide leaflets, which describe individual exhibits or series of exhibits that are of especial interest or importance. These are all available at purely nominal cost to anyone who cares for them.

The scientific publications of the Museum, based on its explorations and the study of its collections, comprise the *Memoirs*, devoted to monographs requiring large or fine illustrations and exhaustive treatment: the *Bulletin*, issued in octavo form since 1881, dealing with the scientific activities of the departments, aside from Anthropology; the *Anthropological Papers*, which record the work of the Department of Anthropology; and *Novitates*, which are devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters. The Librarian of the Museum, who may be addressed in care of the Museum, may be called upon for detailed lists of both the popular and the scientific publications with their prices.

Expeditions from the American Museum are constantly in the field, gathering information in many odd corners of the world. During 1927 thirty-three expeditions visited scores of different spots in North, South, and Central America, Asia, Africa, and Polynesia, and nearly as many are now in the field continuing last year's work or beginning new studies.

From these adventuring scientists, as well as from other members of the Museum staff and from observers and scientists connected with other institutions, NATURAL HISTORY MAGAZINE obtains the articles that it publishes. Thus it is able to present to the constantly enlarging membership of the American Museum the most fascinating and dramatic of the facts that are being added to the Museum's knowledge, or are deposited in this great institution.

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The Journal of The American Museum of Natural History

HAWTHORNE DANIEL
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AN ENCHANTED FOREST OF THE MICROSCOPIC WORLD

A detail of the new Rotifer Group in the Darwin Hall of the American Museum, constructed entirely of glass, and faithfully portraying many of the strange plants and animals that normally might be found in one half inch of pond bottom, magnified to more than four feet in diameter

VOLUME XXVIII

NATURAL HISTORY

NUMBER FIVE

SEPTEMBER-OCTOBER, 1928

BY AIR TO THE ENDS OF THE EARTH

Modern Methods in Polar Exploration. The Difficulties and Advantages of Arctic and Antarctic Air Routes. The Problems to be Faced in Air Travel in the Antarctic

BY VILHJALMUR STEFANSSON

WHEN Byrd and Wilkins, two of the chief heroes of northern flying, go south this autumn to face tragedy or triumph in the Antarctic, we turn naturally to a study of the contrasts and comparisons that describe the two ends of the earth.

The similarities are fundamental, of course. At the mathematical poles, whether north or south, you have the sun visible above the horizon for about one week more than six months, and there is darkness so that you could not read ordinary newspaper print out of doors for something between four and five months each year. But this is never pitch darkness such as we know in the tropic or temperate zones. Clouds are rare in the Arctic in midwinter and are even fewer and thinner toward the center of the Antarctic, so that the light of the stars comes through in both places. Auroras ranging from gorgeous to pale are common, too, and a medium aurora gives about as much light as the combined brightness of all the stars. On a moonless but cloudless night you could therefore see a man dressed in black half a mile away. With even a quarter of the moon in addition, you could see him as a dot on the landscape three or four times that far. When the moon is anything from half to full, you can see mountain peaks no matter how far away if they are above the horizon. Even on a cloudy night with no moon, you could see a figure in black one or several hundred yards distant, for in winter there is snow over both land and the sea in the Arctic that reflects and doubles the light. In the Antarctic there is snow both winter and summer.

So far as light is concerned, you can therefore do night flying with greater ease and safety in the Arctic or Antarctic than you could in the rest of the world.

For winter flying, cold is not a handicap at either end of the earth, so long as you are in the air. Cold has, on the contrary, the slight advantage that it makes the air heavier, and that the airplane can therefore carry more weight or rise more easily with the same weight. It has, too, the greater advantage that the lower the mercury the calmer the weather and the more clear. Since clouds and fog are the greatest enemies of the flyer, cold is to that extent his best friend.

But after a forced landing, extreme cold

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THE MOUNTAINS OF SPITSBERGEN FROM THE AIR

Between Spitsbergen and the North Pole the aviator flies over no such peaks as these, for the North Pole lies near the center of a frozen sea. This photograph, however, gives some idea of what the aviator must face in attempting the flight to the South Pole, which lies near the center of a rugged, ice-clad continent

may well be a drawback. It is hard to work on metal with metal tools except when using mittens, and they are clumsy when handling small or delicate things. It has been estimated by some that, other things being equal, it is at least 30° colder in the Antarctic than in the Arctic, and my own opinion is that the difference is probably greater. A forced landing in winter, in that respect, would be more dangerous in the Antarctic. This is a purely academic situation, however, for, as we shall show when we discuss contrasts, there is every reason for midwinter Arctic flying and no reason for midwinter Antarctic flying.

The two magnetic poles are located near the edges of the Arctic and Antarctic circles, each more than a thousand miles from the mathematical pole. The difficulty in using ordinary magnetic compasses has everything to do with the magnetic poles and nothing with the mathematical ones. There are commonplace shipping routes in the temperate zone that are nearer the north magnetic pole and more influenced by it than if they lay across the mathematical north pole. It is therefore merely one of the common mistakes to suppose that flying in either the Arctic or the Antarctic is necessarily more difficult than in the temperate zone because of magnetic conditions. Wilkins, for instance, when he flew across the Arctic from Point Barrow to Spitsbergen, was never in greater difficulty with magnetic forces than the ships of the Hudson's Bay Company have been every year for the last two hundred fifty when taking their cargoes from England to the fur posts on Hudson Bay. The magnetic troubles of Byrd when flying between Spitsbergen and the North Pole were even

less; in fact, no more than those of passenger ships that ply between Liverpool and Montreal.

A fundamental similarity of the far north and the far south is that snow and ice are permanent throughout the twelve months of the year only on mountains or where low land is so near a mountain that the ice which forms in high altitudes can flow down upon the plain. This similarity leads to a contrast, for the Antarctic is higher above sea level than any other equally large area in the world. More than 99 per cent of the known Antarctic continent is therefore covered with ice. But the Arctic lands are usually low; in consequence less than 25 per cent of them have a permanent ice covering. The rest of the Arctic lands have snow in winter which all goes away in summer.

The contrasts between the Arctic and the Antarctic are even more fundamental than the similarities, and they are more numerous. To begin with, the Arctic is mainly water while the Antarctic is mainly land.

The Antarctic is a continent larger than Australia or Europe. But the Arctic is an "ocean" only by courtesy, or perhaps, more rightly speaking, by mistake. For it is only on Mercator projection maps that it looks big, which is only because everything far from the tropics is magnified. On a map of approximately uniform scale, or on a globe, where you can get the strictly right proportions, you will see that the Arctic is a mere gulf running north from the Atlantic. More properly, it is a mediterranean sea separating North America from Asia somewhat as the old Mediterranean separates Europe from Africa.

The position of the Antarctic surrounded by ocean and the Arctic surrounded by land makes a fundamental

Mawson Australasian-Antarctic Expedition

THE EDGE OF THE ANTARCTIC CONTINENT

The Antarctic land mass rises from the ice-infested southern seas to altitudes of ten thousand feet or more. Covered almost entirely by ice and snow and surrounded by water, this portion of the globe is a breeding place of storms, although at the pole itself it is probable that storms are rare and that the winds are generally mild

difference in human values. We have no economic or other so-called practical motives for wanting to cross the Antarctic by flying or in any other way, for doing so does not take us from one inhabited land to any other. Glance at a globe and you will see that if you go straight from Australia or New Zealand to either South America or South Africa you do not cross the Antarctic, nor would you if you flew between South America and Africa. But in the northern hemisphere, if you draw on the globe the shortest distances between the great cities of the old and the new worlds, you will find many of the lines crossing the Arctic, and some running near its center. This is why there were important commercial deductions to be made from the Amundsen-Ellsworth flight in the Norge from Spitsbergen to Alaska. Also, the comparative ease and certainty with which Byrd flew and navigated from Spitsbergen to the North Pole and back demonstrated the possibilities of Arctic air lanes. And Wilkins was a great pioneer in transportation when he not only flew across the full width of the Arctic from North America to Europe, but also reported that the flying conditions on that route were better than on any routes of the same length known to him either through his extensive flying experience in the tropics and the temperate zone or through his reading and the reports of travelers and scientists. For this meant that the shortest routes between great cities were also in many cases the easiest and safest.

The Antarctic continent, then, is so located that it will never be a thoroughfare. The Arctic Ocean is so located that, in view of its favorable conditions, it is

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THE N-25, OF THE AMUNDSEN-ELLSWORTH 1925 EXPEDITION

The first attempt to reach either of the poles by the use of airplanes was made in 1925 by the expedition led by Roald Amundsen and Lincoln Ellsworth. Using two airplanes, the expedition ran into adverse winds and, having used up half their gasoline, they landed in order to determine their position. They had reached 87° 44′ North Latitude, but they having landed in a lead, the ice closed in and the party was forced to remain for twenty-five days before managing to get away in the N-25 for the return flight

Courtesy of the Amundsen-Ellsworth 1925 Expedition

THE RETURN OF THE N-25

After having been given up for lost, the Amundsen-Ellsworth 1925 Expedition electrified the world by reappearing in Spitsbergen after an absence of twenty-five days. One plane had to be left behind on the Arctic ice, and only after the most grueling labors had the party been able to rescue the other plane and prepare a runway on the ice that would permit the machine to rise

bound to be covered within the next half century with a network of airways connecting the world's commercial centers. Dirigibles will fly at all seasons on straight routes, like ocean steamers, one of them completing the whole voyage. The airplanes will fly on routes less straight, for they will have to travel by relays as our railway locomotives and transcontinental air mails do now.

There is a similarity in the abundance and distribution of life in the seas of the north and south, but a contrast on the lands. As you proceed in the ocean either north or south from the equator, you discover more animals the farther you go, so that when you get to Alaska, Newfoundland, Norway, or Spitsbergen in the northern hemisphere you find incredible quantities of herring, cod, seals, and whales. Such life increases even faster as you go south, or at least it is more abundant at the edges of the Antarctic than anywhere else in the world, so far as we know. This greater southern abundance is very probably only the result of two main facts: that there are more square miles of ocean than in the north, and that man, the great beast of prey, has not as yet devastated the southern ocean as he has the northern.

But in the south the margin of the land is the boundary of animal life. The seals and the penguins do crawl a few hundred yards from the water occasionally, and they cannot go farther. Beyond that there is only a little plant life. Two flowering plants have been found in the Antarctic and a few score of the non-flowering mosses and lichens.

In the Arctic, too, the seals and many of the sea birds are confined to the beaches, but some of the sea birds, such as the gulls, go far inland. Then there are in the Arctic not two flowering plants but several hundred, besides several hundred

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THE ANTARCTIC CONTINENT PROBABLY OFFERS SCENES LIKE THIS

Although this photograph was taken from an airplane flying over the rough land around Spitsbergen, it probably shows a scene not greatly different from many that Byrd and Wilkins will find in the far south

Wide World Photos

BYRD'S PLANE ASHORE IN SPITSBERGEN

Just prior to his flight to the North Pole. Within a few hours after Byrd's return, Amundsen and Ellsworth, this time in the dirigible Norge, left Spitsbergen and made the first crossing of the Arctic Ocean

Courtesy of the Amundsen-Ellsworth 1925 Expedition

A VIEW OF THE NORTH POLAR ICE

Undoubtedly the problems to be solved by the aviator bent on reaching the South Pole are even greater than those that have to be overcome in the north. Many difficulties lie in the aviator's way in the north, but great altitude is not one of them

"International Newsreel"

THE PLANE IN WHICH WILKINS CROSSED THE POLAR SEA

Because Amundsen and Ellsworth, in the Norge, had flown from Spitsbergen to Alaska over the Pole, Wilkins flew a different route between Alaska and Spitsbergen. Neither located any new land in the Arctic Ocean

Courtesy Amundsen-Ellsworth 1926 Expedition (N. Y. Times Photos)

THE NORGE LEAVES SPITSBERGEN

This photograph of the Amundsen-Ellsworth dirigible, taken from Commander Byrd's plane by Russell D. Owen, shows the start of the first successful flight across the Arctic Ocean

species of mosses and lichens, and more than a score of ferns. It was formerly thought that mosses and lichens were the chief vegetation of the Arctic, but we now know that in tonnage flowering plants are at least ten times more abundant there and probably a hundred times. They are found not only on the north coasts of the continents but also on the north coasts of the remotest islands that are far beyond the continents. Forests of spruce and other trees go well inside the Arctic circle, even where there is no Gulf Stream or other warm ocean current to help them.

Because the plants are numerous, the insects, birds, and quadrupeds that live on them are numerous in the Arctic, too. Peary met a bumble bee half a mile north of the most northerly land in the world. DeLong met a butterfly twenty miles away from the nearest island when he was more than 700 miles north of the Arctic circle. Both the caribou (reindeer) and the ovibos (musk ox) have been found grazing on the most northerly islands. They do not migrate, and are as prosperous there in mid winter as in mid summer —in fact more prosperous, to judge by how fat they are at different seasons. There are more than 150 species of birds that go to the Arctic every summer to breed, and the individual birds are there by the million. Some of the birds, too, spend the whole year—a few ravens, a few owls, and thousands of ptarmigan. A caribou herd that moved past my Arctic camp in 1910 must have counted several hundred thousand, probably more than a million. It took them four days to march by and the column was four miles wide.

In contrast to this, the Antarctic has no land mammal at all. If there is any vegetation far from the coast it is only a rare lichen or moss on a projecting rock;

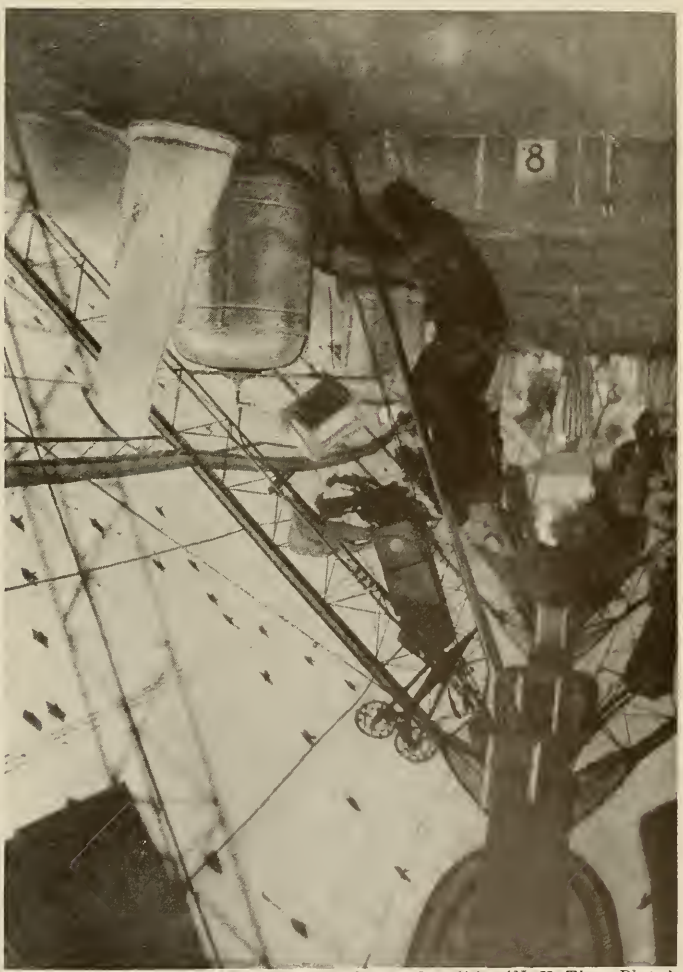
perhaps, beyond them, may be found some bacteria or similar plant growing in the snow.

The human adventure of discovery, controlled by natural forces, has been fundamentally different in the north and south. There was a time when everybody believed that the Arctic was as snow covered and lifeless as the Antarctic really is, but theories change as knowledge grows and practise adapts itself to them. The earlier post-Columbian explorers of the Arctic thought that they could work only in summer and would have to flee home before autumn. Those who were caught by the winter ice expected to die, and most of them did die. These men were really frightened to death, in the sense that their fear of the Arctic destroyed their competence. Some more literally died of fright, for gloom and dread spoil digestion and ruin health.

When it gradually appeared that this extreme dread of the North was auto-suggestion, the theory and practise grew to be that journeys afoot could be made in spring and fall, with the explorers hibernating through the winter. That condition held till the middle of the last century when McClintock and some other Englishmen broke away from it during the Franklin search, beginning to travel in March, which in the Arctic is as cold as any month of the year.

It remained for Peary to finally overthrow the dread of the Arctic winter and to teach men to fear instead the effects of the summer heat. He eventually laid it down as a principle that successful sledge exploration over the Arctic sea must begin in February or March, and should end in April or early May. This plan led to safety, to success, and even to comfort, in the last work of discovery that had to be done on ice that was afloat and constantly drifting back and forth upon the Arctic Sea.

The Antarctic is really as icy and life-



Courtesy Amundsen-Ellsworth 1926 Expedition (N. Y. Times Photos)

IN THE RIGGING OF THE NORGE

The equipment included tents, sleeping bags, skiis, snowshoes, rifles, shotguns, ammunition, a hand-sledge, and a big canvas boat

ARCTIC AIR LANES

The Arctic Ocean, entirely surrounded, as it is, by land, will undoubtedly some day be crossed by air lanes leading between the important centers of Europe, Asia, and North America. The shortest routes from New York or Chicago to any Asiatic city of consequence lead across the Arctic, and many other routes do the same

less as the theorists formerly supposed the Arctic to be. There is really an ice cap too, such as was formerly supposed to cover the Arctic. Therefore the travel methods that used to be considered suitable for the Arctic are really suitable for the Antarctic. Whether you are going to sledge or fly, your work in the South begins in spring, extends through summer, and ends in the fall.

In the Arctic, darkness does not interfere with flying as such in midwinter, but it does interfere with exploration; for there is not much use flying over a place unless you can see pretty clearly everything within your horizon. The exploring season is therefore short . . . say from the middle of February to the beginning of May . . . and during the first half of it you are somewhat handicapped by darkness. Moreover, you are flying in the early part of your season at the lowest winter temperatures. In the Antarctic, with seven months of clear daylight available, you do not begin until the lowest cold of winter has passed, and although the midwinter temperature of any given place is at least 30° lower in the South than in the North, still the northern flyers, like the northern sledgers, will continue to do their work at temperatures averaging at least 30° colder than those of the Antarctic.

As to storminess, there are both similarities and differences between the North and the South. The underlying similarity is that storms in both places are violent and frequent only where there is high land fronting on open sea. This means, however, that storms are frequent and violent along most of the coast line of the Antarctic continent, but only in rare places in the Arctic. Taken as a whole, the Arctic has the least storms for an area

of that size in the northern hemisphere, winds both fewer and less violent. The Antarctic land margin, on the other hand, is the stormiest region of the whole world.

It follows from what we have just said that as you proceed toward the center of either Arctic or Antarctic the winds become fewer. However, there is no completely windless spot in the Arctic; but it seems probable that there is an area of a great many thousand square miles in the Antarctic where no strong wind ever blows. At least Amundsen came to the conclusion that no considerable winds ever blew right at the mathematical south pole.

It appears, then, that the work planned by Wilkins for the Antarctic is as dangerous as it is scientifically important. Nothing concerns geographers so much down there as to determine the coast lines and therefore the extent of the continent. If Wilkins carries out his projected flight of more than 2000 miles along the continental edge, he will fill up the biggest gap there is in our Antarctic geographical knowledge.

Wilkins has a theory that while all the other margins of the Antarctic continent are high, the unknown coast he wants to explore is likely to be low. Solving this problem is of great interest to geographers, and of perhaps even more importance to meteorologists. For if this be a low coast, then the violent winds found on all the other sides of the continent may be absent here, as the known storms are supposed to be caused in large part by the mere gravitational flow of heavy cold air down grade towards the sea. If the coast proves to be high, there will be violent storms at right angles to his course blowing him straight out to sea, and if he ever comes down in the water or on the loose ice,

THE ANTARCTIC

The Antarctic differs in many ways from the Arctic. Where the North Pole lies in the center of a deep ocean, the South Pole lies in the heart of an ice-covered continent. Where the Arctic Ocean lies along the shortest routes between many important centers of population, the Antarctic Continent does not. The shortest routes between the tips of Africa, South America, and Australia all miss the South Polar land mass

there is no further hope. For (if the coast is steep) there will be heavy seas running on the water and the cakes of ice will all be floating rapidly seaward. This direction of ice movement is one more fundamental difference between the North and the South. Every cake that once gets adrift from its Antarctic moorings will float steadily away till it melts in the warming sea; but in the Arctic most cakes that float away from one land are only floating towards some other. The peril of drifting into the open sea, found everywhere in the Antarctic, is found in the Arctic only near Spitsbergen.

But while the scientific problems that hinge on the Byrd plans do not thrill the geographers and meteorologists quite so much, his plan is the better of the two, and more sensible, in that it is safer, for he intends to fly straight inland. If he can find a good base on the coast and then start during a calm, he knows that any wind that strikes him within the first few hundred miles is bound to be a direct head wind, so that if it proves too violent to stem, he can always turn about and use it as a tail wind to carry him home, whence he can make a second start. Moreover, the calm he chooses to fly in will probably last several hours, if not days, so that he will get beyond the coastal belt of violent storms before he has any opposition. If he then wants to fly to the South Pole, as he did to the North Pole, he can count not only on calm weather, at least from the half way point to that destination and back again half way, but can also be sure that if after he passes the half way point on his return there is a strong wind, then it will be one that carries him towards home. On the other hand, if he decides after reaching the South Pole to continue across the continent to the opposite coast, then he knows that any wind he runs into will be a fair wind and that the only danger in it will be that it may make safe landing difficult where the flight should end near the sea.

Flying the Arctic has a transportation significance which flying the Antarctic cannot at present be seen to have. In that respect, the southern work is in the field of pure rather than applied science. But it is not to be condemned for that reason, at least by nations that spend millions a year on the study of nebulæ that re amore remote and have less prospect of commercial development than even the center of the Antarctic continent.

But there are commercial aspects to the southern plans. The three chief lands radiating from the Antarctic . . . Africa, South America, and Australia . . . have vast grain fields that are cultivated on a bare margin of rainfall, so that a small decrease in the expected rain means poverty to thousands of farmers and even, in some cases, national distress. There are flocks grazing, too, in all these countries, on plains that burn up if the weather is too dry so that the beasts die by thousands. If only these countries knew a year or a few months in advance how dry the weather was going to be, they could control their planting, and they could ship and sell their animals while they were fat. There is a prospect that some day the science of meteorology will be able to foretell lean years. But, in the southern hemisphere at least, this development cannot be thought possible without a full understanding of weather conditions in the Antarctic.

The chief "practical" angle of the Byrd and Wilkins expeditions is, therefore, the direct contributions they may be able to make to meterological knowledge, and more especially the advice they may be able to give when they return as to where and how permanent radio weather observatories can be established that will furnish such constant and systematic reports as shall finally enable us to predict the comings and goings of wet and dry seasons in the South Temperate Zone.

THE CROCKER LAND EXPEDITION

The Story of the Last Extensive Dog-Sledge Expedition in the Arctic. The Final Effort in Three Hundred Years of Dependence on Brawn and Sinew Among the Ice Floes of the Frozen North

By FITZHUGH GREEN

The Crocker Land Expedition was organized under the auspices of the American Museum of Natural History, in New York, and the American Geographical Society. Contributors of funds and equipment to the expedition included Yale, Harvard, Bowdoin, and Illinois universities, and the Federal Government. It left New York in June, 1913, and after basing four years at Etah, North Greenland, returned in the autumn of 1917.

The purpose of the expedition was to solve the last great geographical problem of the north: Is there in the Polar Sea a large body of land still undiscovered? Geographers had produced evidence contrary to this supposition. Oceanographers and tidal experts upheld it. In 1906 Admiral Peary reported he had seen new land some hundreds of miles west of Cape Columbia. He named it Crocker Land after one of his backers, and the expedition hereinafter described had as its chief aim the verification of this report.

The objects of the expedition were scientific in character and may be briefly summarized as:

(a). Actually visiting, reconnoitering, and mapping Crocker Land or the sea ice at or about its supposed vicinity.

(b). Scientific exploration of the region between Flagler Bay and Cape Thomas Hubbard and of the Ellsemere Land interior.

(c). The attainment of the Greenland Ice Cap east of Cape York.

(d). The collecting of data and specimens along all scientific lines as far as practicable, including ethnology, geology, botany, seismology, ornithology, geophysics, terrestrial magnetism, meteorology, oceanography, and chemistry.

(e). Coöperation with the U. S. Weather Bureau for practical as well as research purposes, through wireless connection with a Canadian station which was to have been erected in the Hudson Bay district the summer the expedition sailed.

The scientific staff was as follows:

Donald B. MacMillan, A.B., A.M., leader and ethnologist.
Fitzhugh Green, M.S., U.S. N., engineer and physicist.
W. E. Ekblaw, A.B., D.Sc., geologist and botanist.
M. C. Tanquary, A.B., A.M., Ph.D., zoologist and biologist.
Harrison J. Hunt, A.B., M.D., bacteriologist and surgeon.

Jerome Lee Allen, chief electrician, received orders from the Navy Department to join in New York, and Jonathan Small was engaged at Battle Harbor, Labrador, as cook and mechanic.

The chief success of the expedition came in 1914 when MacMillan and Fitzhugh Green sledged across Ellsemere Land and out over the Polar Sea, emerging upon unexplored area, but failing to discover Crocker Land at or near its supposed location. Peary's cairns and records were picked up at Cape Thomas Hubbard.

During succeeding years sledge journeys were continued westward across Ellsemere Land and through known areas to the south and west of Axel Heiberg Island, as far as King Christian Land.

The sealer NEPTUNE, under command of Captain Robert A. Bartlett, brought the last of the party back in September, 1917. Unless otherwise noted, the photographs in this article are by Donald B. MacMillan—The Editors.

ARCTIC exploration now belongs to the airplane. The dog sledge is in a class with the prairie schooner.

Hence, our Crocker Land expedition to Greenland and the Polar Sea, 1913–1917, the last extensive dog-sledge effort in the north, marked the end of one of the romantic periods of human enterprise. Further, as this expedition was in a technical way the culmination of all past arctic experience, its human interest was unusual, aside from its scientific activities.

Our plan really got its start in June, 1906, when Peary scanned the northern horizon of the Polar Sea while standing at Cape

THE "ERIK" ANCHORED AT ETAH, NORTH GREENLAND
The "Erik" was a fifty-year-old ship that was chartered after the "Diana," which had originally been chosen, ran ashore on Barge Point, in the Strait of Belle Isle

Thomas Hubbard, the northern extremity of Axel Heiberg Land, which he had reached from his base near Cape Sheridan to the east. Later he wrote: "*The clear day greatly favored my work in making a round of angles; and with glasses I could make out apparently a little more distinctly in the northwest above the ice horizon the snowclad summits of a distant land.*" He named his discovery Crocker Land.

Geologists politely controverted this report. Experiment had proved that when a sphere of viscous matter is revolved it tends to assume the form of a tetrahedron with the axis of revolution through one apex and the center of one plane.

Peary's soundings near the North Pole gave a depth of 1500 fathoms,while Scott and Amundsen found the elevation of the South Pole to be eleven thousand feet. This bore out the theory that the South Pole was at the apex of the tetrahedral and the North Pole at the center of the fourth tetrahedral surface; it further implied that the whole polar basin was fairly flat and covered by the sea. By this reasoning new land was unlikely.

The other side of the argument was supported by many reports that land had been seen north of Alaska, and by tidal analyses by Dr. R. A. Harris of the Coast and Geodetic Survey which showed that currents crossing the top of the world indicated a Crocker Land.

At this writing, Amundsen and Wilkins have both flown over portions of the unexplored area of the Polar Sea above the American continent. Without finding new land they have narrowed down the million or so square miles that had never been seen by human eye when MacMillan and I went out by dog team. But there still are large spaces left to be checked up.

Happily, we shall soon know the full truth as a result of the industry of our modern air explorers.

We gathered in New York toward the end of June, 1913. On our small and old-fashioned expedition only seven men were taken. The horrors of past expeditions when scores perished in a single arctic night had proved the danger of a large personnel. The *Diana*, a 400-ton sealing vessel out of St. Johns, had arrived from the north. After ten days' loading we set sail for the Greenland coast. The *Diana* was wrecked on the Labrador. But we were able to secure another sealer, the *Erik*, from St. Johns, and again set forth northwards.

At about 75° N. the Greenland coast swings to the west forming huge Melville Bay which terminates in Cape York. Ellesmere Land opposite trends east. Together the two coasts form a long flask of which the neck is Smith Sound and the flask Kane Basin. The latter connects with the Polar Sea through Kennedy Channel about 20 miles wide and twice as long. Polar ice and glacial bergs pour down into Kane Basin and choke the northern entrance to Smith Sound. But the earth's revolutions, combined with a northerly tidal set, crowd ice along west Greenland shores until the current is deflected by Melville Bay and again by Wostenholme Sound, where the crashing, grinding masses are carried across and down the western side of Baffin Bay.

In early August we established our base at Etah, the northern limit of the little tribe of Eskimos living thereabouts, and on the east side of the bottle-neck just described.

The little tribe with whom we intended to live belonged to the unspoiled type. Early British expeditions reported these natives savage and treacherous. It is possible that this was assumed after several

A SLEDGE ON THE ROUGH ICE OF THE POLAR SEA

Over such ice as this only the slowest progress can be made. After a heart-breaking day's labor one is likely to have made very little headway, and that only by risking serious damage to sledges and dogs

A POLAR BEAR ON A BERG AT ETAH

These handsome animals are perfectly at home on the ice or in the icy water, and are to be found, occasionally, far out on the ice of the Polar Sea

LITTLE AUKS

Bird life in the Arctic is variegated and far from rare. Little auks arrive in North Greenland from the south about the middle of May, and leave for the south again in August

Photograph by E. O. Hovey

BORUP LODGE

The headquarters of the Crocker Land Expedition at Etah. Here, on the shore of Foulke Fiord, within 700 miles of the North Pole, this structure was erected

SUMMER ON THE SHORE OF ALIDA LAKE

Hunt, Green, and Allen, of the Crocker Land Expedition, with a group of Eskimos near Brother John Glacier which marks the end of Alida Lake, the uppermost portion of the fiord at Etah

DIFFICULTIES OF NAVIGATING FOULKE FIORD

The electrical and wireless equipment of the expedition was transferred from Etah to Starr Island with the aid of the motor boat and one whale boat. Starr Island was about two miles from the headquarters at Borup Lodge

centuries' experience with the North American Indian; and an Eskimo is inclined to do as he is done by. Peary, however, gained their confidence and fairly won their friendship and admiration. They speak of him as "the white man who never lied"; as "the one who was always ready to work in the morning"; and as "he (the white man) who dares come back." He found them childlike and often unreliable, but usually honest and loyal, and capable of work and hardship to an incredible extent. Endless generations of the fight they wage for existence have made them almost perfect in the art of arctic travel. Peary cleverly recognized their value as assistants, thereby outdoing his predecessors until he finally reached the Pole.

By October we were pretty well settled so far as living quarters were concerned. The little shack we had built on the beach was a great success. From the Eskimos we learned what winds to expect, and frequent northeast gales proved their information correct.

At MacMillan's suggestion each white man formed particular friendships among the visitors, in order that those of us who should travel might live for a time in native style and assimilate so far as possible the habits and tricks of Eskimo life. Our system involved a deliberate descent to primitive existence for the purpose of mastering such arts as dog driving and building snow houses.

Sipsu took my fancy from the start. He was stocky and lithe, reserved but alert, and clever beyond many of them older than himself. Four children, a wife and a mother-in-law depended for their living upon his skill with harpoon and lance. He taught me to build a snow house and start a native lamp with moss and

blubber. He explained how one must trail and meet a bear, first in his autumnal satiety, and last in the fierce bloodthirstiness of his spring famine. By watching Sipsu I came to understand the care of my feet—vastly important in the bitter nights and the long marches. I observed his dog discipline, and practiced my whip stroke in imitation of his own. Detail by detail I mastered the unwritten lessons which every Eskimo boy must learn before he dares go abroad amid the treacheries of cold and wind and darkness.

Each white man took his course. It was not easy; rotten meat and vermin could not go easily with ten centuries of culture. We stuck it out, though, and thereby bought our lives, as later experience showed us. By December four of our party were fit to take the trail for serious work.

Our garments were entirely native except the single suit of woollen underwear. We found the Eskimo costume remarkable for three qualities: lightness, warmth and durability. My whole outfit in which I was able to travel and, by tightening a few strings, to sleep without a bag at 60° below zero Fahrenheit, weighed no more than did my naval uniform overcoat. Boots were of sealskin, hair scraped off and paper thin, loose fitting, with heel and toe thongs like a snowshoe. A drawstring at the knee kept snow out. Stockings from the arctic hare were soft as down. Between the soles of boot and stocking was placed a thin insulating layer of dried grass. This was changed every night on the march in order to prolong the period allotted to each set of footgear before drying was necessary.

By Christmas a ton of depoted provisions were out. As much more fresh meat was in from the south, and skins sufficient for full outfit had been procured. Our Christmas party had been advertised

Photograph by Fitzhugh Green

COMMANDER MACMILLAN, THE LEADER OF THE EXPEDITION
Taking an observation on the Polar Sea in order to determine the position of the party

DIFFICULT SLEDGE WORK NORTH OF ETAH

This hill, near Anoritok, lies between Etah and the Humboldt Glacier, in a district occasionally visited by the native Eskimos

A CAMP ON EIDER DUCK ISLAND

On one occasion 4000 eider duck eggs were gathered near this camp in order to supply the needs of the expedition

A STEEP HILL NEAR ETAH

In order to travel from the fiord inland, it was necessary first to scramble up this hill, before the less abrupt section of the trail was reached

Photograph by Fitzhugh Green

A VIEW FROM STARR ISLAND

Where the electrical equipment of the expedition was installed after having been transferred from Etah

some weeks previously in order to attract the men we expected to have make up our sledge caravan. We taught them the use of tools, which they learned with remarkable speed. A score of sledges were built. Solid oak sides and soft pine cross-bars were furnished to the natives which they lashed and finished to suit themselves. Thongs took the place of nails in this work, and no sailor or rigger in the world could do better than these unskilled savages whose vise-like teeth and strong short fingers are their only tools outside a long knife. Bow drills were little used. Holes for lashings were gouged with a sharp pointed blade, or on cold days shot through with a rifle. By New Year's day the gaunt skeletons of eighteen sledges leaned against our roof.

January came with even more bitter cold, but days soon grew brighter as the sun approached our latitude. February 7 was set for the departure of the first party towards the Polar Sea.

On this first start we reached the mouth of Flagler Fiord about 100 miles from headquarters. Two Eskimos came down with mumps and several dogs died. The weather was bitterly cold. MacMillan decided to go back and reorganize.

On March 11 we made a second start. The weather was cold but a low sun in the south lent a new brilliance to the white snow fields and deepened the blue of the glaciers. Tanquary had frozen both of his feet in February, and Dr. Hunt's services were required at Etah. MacMillan, Ekblaw and I, and eight Eskimos, formed the new party. With empty sledges and large teams we sped across Smith Sound and down Hayes Fiord, reaching the scene of our recent failure in two marches. Here already were two tons of provisions, more than we needed for the reduced

JEROME L. ALLEN, WITH HIS DOG TEAM

The hardy dogs that supplied the motive power for the expedition's sledges were sometimes used during the short summers as well

Photograph by E. O. Hovey

ESKIMOS STARTING ON A MARCH

Upon the Eskimos of the vicinity of Etah the expedition was forced largely to depend, and several of them proved very useful during the four years the expedition spent in the North

number of sledges, or at least more than we could carry.

At the head of Beistadt Fiord we were confronted by the Ellesmere Land Glacier which flows in at this point. The problem which confronted us quickly put a stop to dreaming. Our party of 11 men and 100 dogs, together with about 6000 pounds of food and other equipment, faced a perpendicular wall of polished ice two miles wide and flanked by unscalable cliffs. At a point 40 feet above us the icy buttress sloped back slightly, and at 600 feet up, rounded into the main glacial body which mounted at an angle of 30° to the ice-cap shimmering against a pale sky. We could well imagine cutting steps in the steely ice, but 48 hours at the most was all we dared spare for the job. We drank our evening tea a little despondently.

All told, in three days we crossed 40 miles, 5000 feet altitude, and a million crevasses, into which we stumbled and dragged ourselves out until fear lost its thrill. We lost our way. We were forced to repeat the ice cutting in order to descend. As near as we could judge we had reached Bay Fiord which Sverdrup had marked when he came up this side and spoke of the impenetrable interior, which we had just crossed.

Then, as is the way with arctic work, plans fell to pieces. Ekblaw disclosed a frozen foot. We had hoped for game; none appeared. We discovered our supplies could not now last beyond Cape Thomas Hubbard; and the extra fuel used on the ice-cap had been in excess of our safe limit. Two hundred miles from the Polar Sea we again faced failure.

On the following day Ekblaw and I with four Eskimos started back over the Glacier. Two Eskimos and I picked up supplies at the main base on the east side

FOULKE FIORD IN SUMMER

Etah is situated on this inlet from Smith Sound, and although it is often called the northernmost settlement in the world, it is hardly a permanent city, for it is made up of only five caves in a sloping hillside, which sometimes are inhabited and sometimes are not

and started west again to overtake MacMillan. After a chase of nearly 300 miles, mostly through smothering drift, I caught him at Cape Thomas Hubbard on the shores of the Polar Sea on April 13th.

On April 15 we headed out over the Polar Sea. Regular observations for latitude checked our dead reckoning. About this time a faint shadow in the northwestern horizon fired us with visions of success. The Eskimos shook their heads. "*Poursuaq,*" they said—"It's just mirage." And so it seemed, for with all the speed of our pursuit, the specter grew no nearer.

Peary placed Crocker Land 130 miles out. At 105 miles we cached most of our food and ran for it. Two marches more placed us beyond the 150 mile mark. The day was perfect, crystal clear horizon, and no wind. We climbed the highest berg and saw nothing. Disappointment is a hard lot after real effort. We swallowed ours, together with a half ration of pemmican, and returned heavy hearted to our impoverished teams.

With empty sledges we double-marched back to land. Twice we were caught in the jaws of grinding crashing pressure. Several narrow escapes on the rubber ice of leads were scarcely noticed in our swift race to safety. Four hours' sleep, forty miles' hike, four biscuit, and a bit of meat, was our program.

We reached the foreshore off the cape with feelings of mixed relief and sadness. Peary's cairn was visible several miles out and had been our guiding beacon above the low scud of ground drift. We climbed to the summit and secured the record, replacing it by a copy and short account of our expedition to date. And we, too, as did our great predecessor, scanned the northern horizon where seamed reflections of ranges of broken ice beckoned in luring falsity. So like land was the phenomenon that, had we not been out, we, too, should have announced its discovery and urged its exploration.

To our west lay a stretch of coast as yet untrod by man. MacMillan magnanimously gave me this opportunity for real discovery and exploration. All the adventurous blood in my veins boiled up at

the prospect. Next morning we separated, he with Etukeshuk towards land in the east, and I with Peewahtoq down the unknown shores in the southwest. The balance of the trip, though long, was without noteworthy event.

May 20 was a red-letter day. Uvdloriark and Acpuddyshao met us at Pim Island. A note from Etah reported all well. Finally a box of jam and canned fruit with plenty of biscuit and tinned meat completed the joy of our return. The dogs were not forgotten. A fine, fat, rotten hunk of walrus meat was apportioned among the teams, who immediately outdid all former records in the violence of their ensuing riots.

Next morning we reached Etah. That home-coming was enough to inspire poetry in the breast of a stone wall. It surpassed the bliss of heaven, marriage, or a raise in pay. In three months we had traveled 1300 miles on pemmican, tea, and biscuit. Remorseless routine of work and sleep, plod-plod-plod, with a tiny ration night and morning, had chained us like some terrible sentence which in the end must have consumed our aching bodies as they strove so painfully to keep going.

The chief geographical task was now finished. In the second year Ekblaw made a traverse of Ellsemere Land up through Greeley Fiord which had never been entered before.

As Rasmussen unexpectedly announced his arrival in the Smith Sound district and his plans to go to Pearyland, this project was called off. Starvation among the Eskimos and many deaths among the dogs curtailed the other work.

In 1916 MacMillan and several Eskimos traveled west across Ellsemere Land to Findlay Island. The following year Capt. Bob Bartlett in the "Neptune" traveled north and picked up the party and its collections.

TWO ESKIMO KYAKS AT ETAH

These tiny skin boats are universally used among the Eskimos when there is any open water. When not in use they are often laid up out of reach of the always ravenous dogs, which otherwise might be tempted to feast on the skin coverings

BABY COTTONTAIL
The big game of the Eastern school boy

Photograph by H. E. Anthony

BR'ER RABBIT'S WIDESPREAD FAMILY

The Numerous Rabbits and Hares That Dwell in Swamp and Thicket, on Plain and Desert and Mountain from Tierra del Fuego to the Mouth of the Mackenzie and from the Atlantic to the Pacific

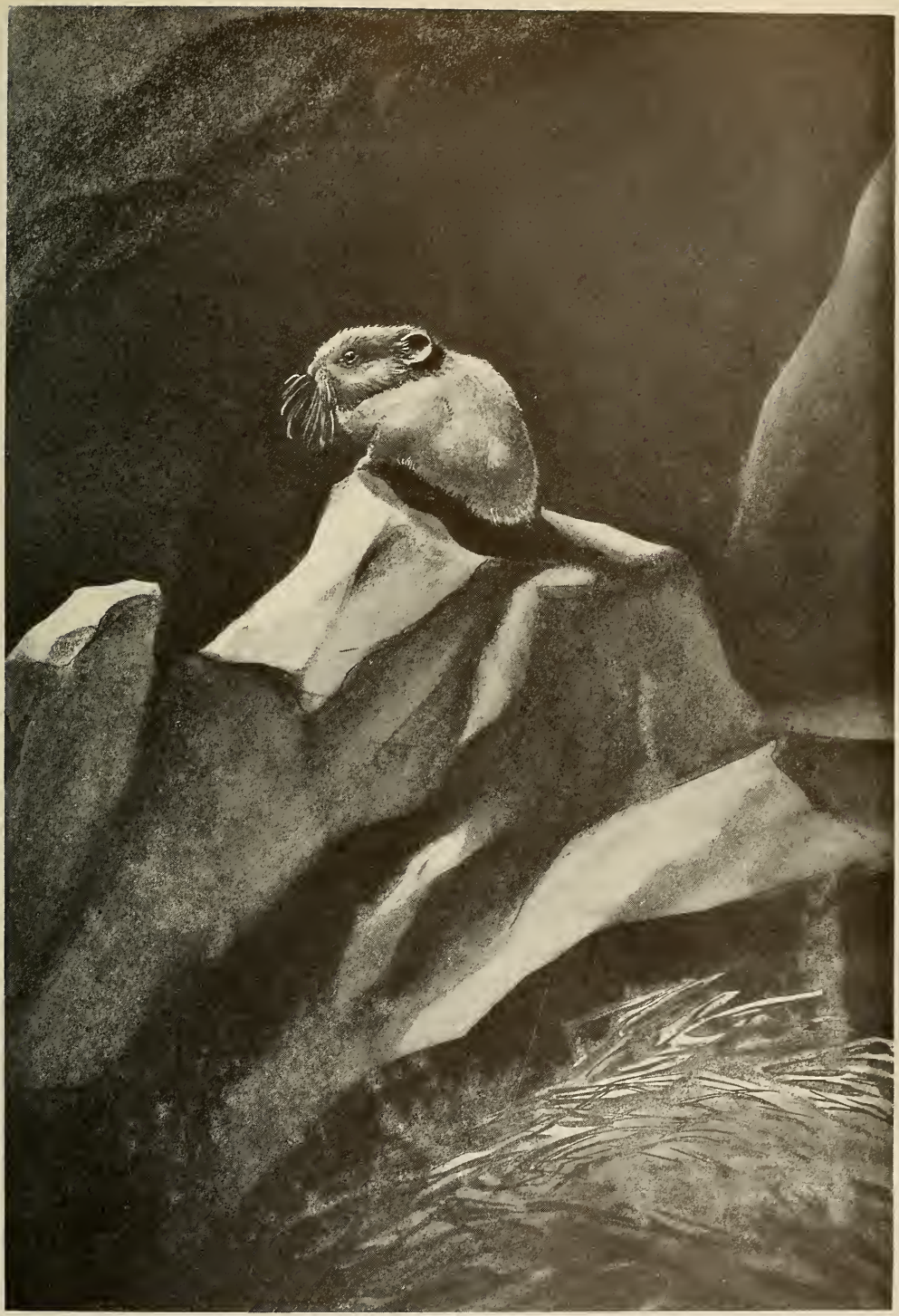
By ROBERT T. HATT
Assistant Curator of Mammals, American Museum
With ten drawings by Francis B. Shields

"IF yo' all has bad luck yo' jess ketch a rabbit by a grave yahd in de dahk of de moon an keep his leff hin' foot about. Calamity woan follah yo' no moah den."

So I was assured near New Orleans. After I crossed to New Mexico, the information was imparted to me that any dead rabbit was good luck, but that a live rabbit was a scourge and a pestilence that consumed the life-giving grass which should go all to beef. And the rancher is not without some just grievance, though it is his cattle that have encroached on the jack rabbit's domain, and not the hare on his.

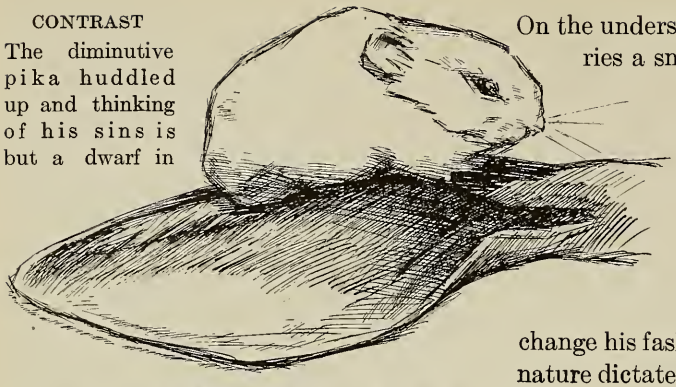
Within the borders of our continent live more rabbits, conies, and hares than in any other. The vast total of individuals is not surpassed and our number of species is above rivalry. In North America alone, science has recognized 143 forms. These creatures dwell from the water's edge of the Atlantic to the wet sand along the Pacific shore; from Patagonia to north Greenland; from the floor of Death Valley to the rock wastes above timberline on our highest peaks.

Greatest of all this host are the hares. In contrast to the rabbits they almost never frequent burrows. Their young are born out in the open, furred and open-eyed, ready to follow their mother when danger threatens. Our rabbits, on the other hand, often make small dens or occupy deserted homes of larger game. In this shelter live the young during their first days in open air, furless, blind, and helpless. High above the homes of these live the final family of this, our leporid trinity, the pikas. With ears almost as short as fur, and innocent of tail, with leapless legs, they live their lives among the rocks that shelter them. No doubt be-



PIKA

These tiny rabbits of the mountain rocks sit for hours sunning, calling back and forth among themselves and at intruders, yet they have heeded Æsop and busy themselves in summer making hay for winter use

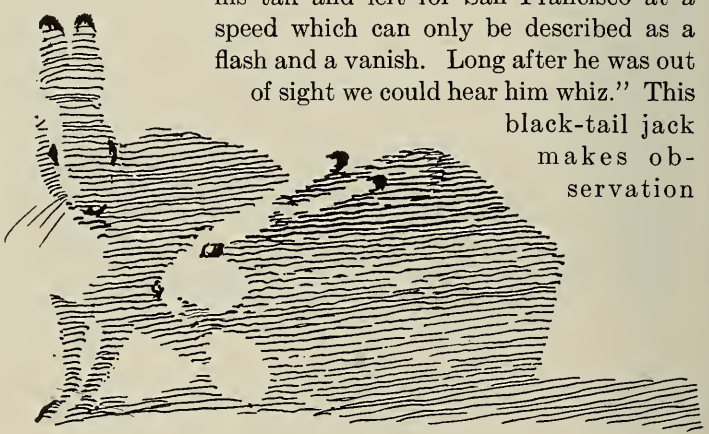


CONTRAST
The diminutive pika huddled up and thinking of his sins is but a dwarf in contrast to the antelope Jack rabbit whose ear is larger than the body of a pika

cause they took up vulgar whistling their relatives banished them to these broken wastes, where they live almost alone. In spite of their multitudinous peculiarities they look for all the world like rabbits and inwardly show themselves as such.

In size the Lagomorphs range from the fifteen-pound hare of Greenland to the diminutive five-ounce pika who is so abbreviated that, if opportunity offered, he could stand upon the ear of a lanky Arizona jack rabbit.

The group has not gone far in brilliant coloration. The backgrounds against which rabbits most appear give the key to their hue, and this key is followed modestly. Living in desolate snowy wastes, the polar hare has taken on a coat completely white but for the smallest group of jet black hairs which tip his ears and furnish marks of recognition. In the dull brush of the temperate States, familiar Molly Cottontail has adopted brown and finds hiding simplified.



POLAR HARES
Were their ear-tips, noses, and shadows not black, the polar hares would be invisible against a snowbank

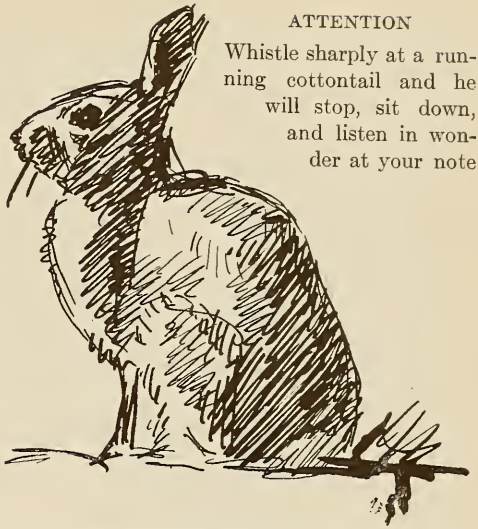
On the underside of her tail alone she carries a snow-white powder puff that those of her sorority may know her. The snowshoe hare confronts a more perplexing problem. In summer he lives in the swamps and woods; in the winter on the snow. Twice a year he must change his fashion and don clothing which nature dictates inconspicuous. The desert hares, or jack rabbits as they are called, assume the pallid hue that their surroundings bear, keeping only the personal touch of black ear tips and a black shield on their tail. One species only disobeys the laws, for there is none to impose the penalty on this vagrant. Espirito Santo is a light-hued desert island in the gulf of Lower California, and here lives this hare that is as nearly black as he can be, no less conspicuous than a white swan upon a well clipped lawn. But enemies are few or none, so the hare does as he pleases, proudly hopping about in sable beneath a tropic sun.

What have we among the hares? A host of jack rabbits whose home is on the plains and deserts, where they can give fullest play to their fine legs and sensitive, rain-shedding ears. Mark Twain first made them famous when he said of one in *Roughing It*, "He dropped his ears, set up his tail and left for San Francisco at a speed which can only be described as a flash and a vanish. Long after he was out of sight we could hear him whiz." This black-tail jack makes observation

leaps four feet into the air, the better to see what his pursuer does; while on the straightaway he leaves ten times his length of earth untouched.

Few things vegetable are shunned by desert hares. Even the spiniest cactus is quickly reduced, if but a small part of its surface is freed of thorns to allow an opening nibble. The rest becomes then easy demolition. The creosote bush is always shunned, and flesh is never taken, but the menu is broad and has been much increased by man, so that where one hare lived a poor life on dry grass before, twenty now thrive on sweet alfalfa and juicy melons.

Living, as they do, amidst a vegetation that presents thorns and claws at every point, one would expect the jacks to be torn and scarred, with ears like storm-ripped banners. Yet the hare has learned the ways that he must go, and seldom is molested. Queer it is, but our barbed wire takes heavier toll than nature's does. On the contrary, the cactus in the hottest deserts is a hare's great blessing. By day one sees his gray form in the shadow of a spiny trunk, moving clockwise from the sun, to keep within the narrow shade. Heat to him is devastating, and he is not prone to run great distances at noon, but sits with drooping ears and dozing senses. A telegrapher from a lonely station in mid-Mojave said that when the crew of the midnight train threw off a cake of ice for him, the hares from all the desert round about drew in to lick the foreign apparition.

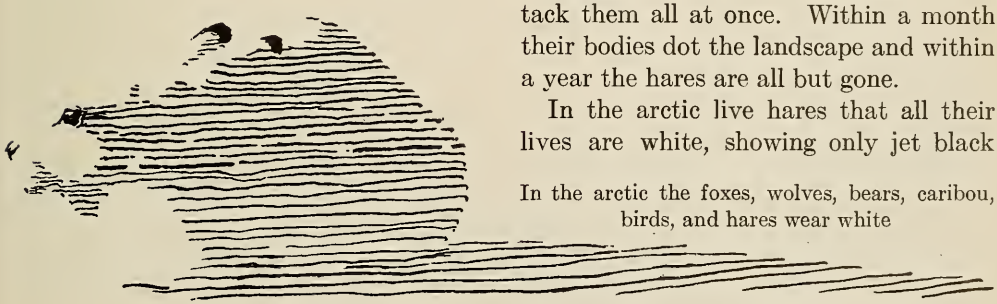


ATTENTION

Whistle sharply at a running cottontail and he will stop, sit down, and listen in wonder at your note

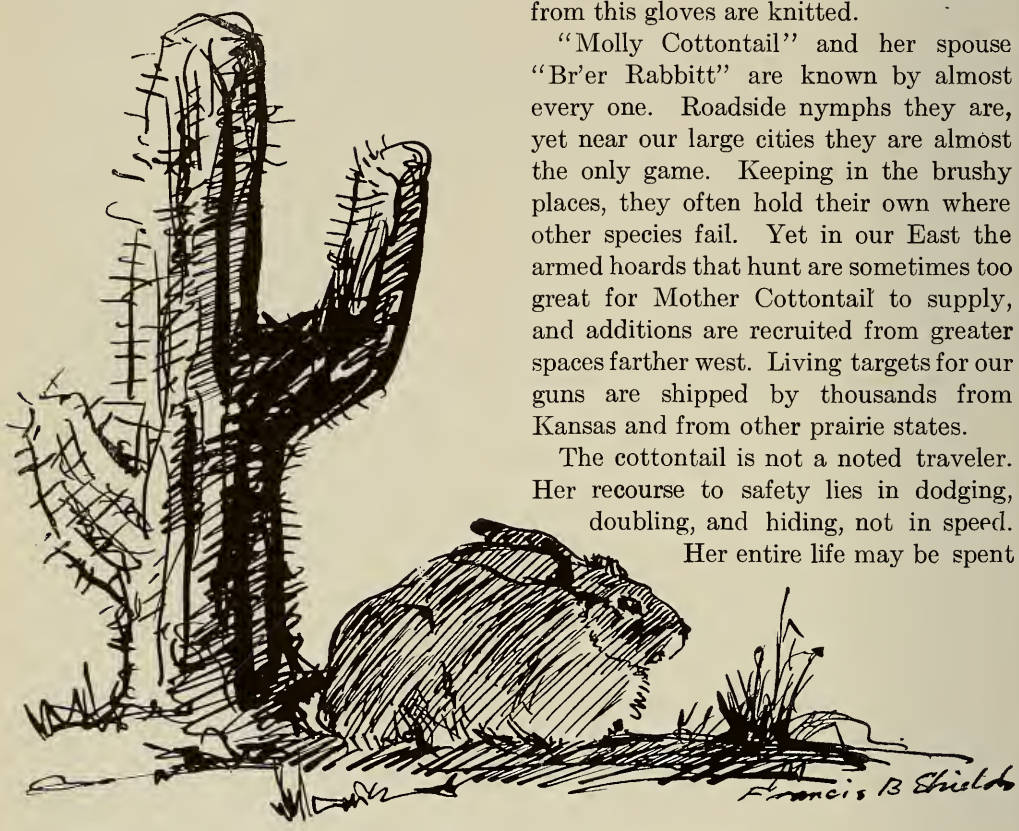
In forests and in heavy woodland brush lives a hare with shorter legs and shorter ears that, with the snow, dons a white coat and grows snowshoes on his feet. Then his brown hair of two months' past does not doom him, nor his slender feet of summer make him flounder in the drift when the fox pursues. His spreading toes, with fringe of hairs along them, support his weight when underfoot it is softest. The varying hare adorns our northern woodlands everywhere. More than that of others in his family, his fame is great for his inability to keep his population in control. Locally, about once in seven years, his kind fills the land to overflowing so that, in two hours' shooting, one man has taken fifty hares and could have increased this number. Hares are everywhere, and then their flocking enemies, famine working fast with undernourishment, parasites and plagues, attack them all at once. Within a month their bodies dot the landscape and within a year the hares are all but gone.

In the arctic live hares that all their lives are white, showing only jet black



In the arctic the foxes, wolves, bears, caribou, birds, and hares wear white

noses, and ear tips. The fur upon their soles lies to a depth of half an inch, like the soft deep pile of a thick carpet.



DESERT SHADE

The desert hares are not advocates of sunbaths and make the most of scanty shade.

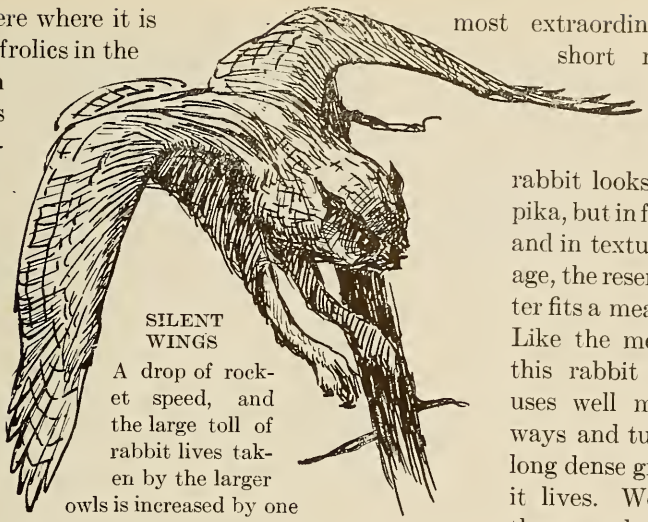
Half hidden in this silenced foot lie claws that are unequalled in the southern species, claws that break the strong crust of the snow when others starve; aided by teeth that are protruding in this hare alone. In Greenland some explorers found the hares incapable of fear, and great droves scarcely kept beyond the reach of the infuriated harnessed dogs. From a man who acted gently toward them they readily accepted food and allowed themselves to be picked up and fondled time and time again. The arctic hares have on more than one occasion saved lost men from starvation. They are a staple diet with the nomads of the north, who also cut the pelt into strips and weave these into priceless light warm blankets. Even the hair is made into thread and from this gloves are knitted.

"Molly Cottontail" and her spouse "Br'er Rabbitt" are known by almost every one. Roadside nymphs they are, yet near our large cities they are almost the only game. Keeping in the brushy places, they often hold their own where other species fail. Yet in our East the armed hoards that hunt are sometimes too great for Mother Cottontail to supply, and additions are recruited from greater spaces farther west. Living targets for our guns are shipped by thousands from Kansas and from other prairie states.

The cottontail is not a noted traveler. Her recourse to safety lies in dodging, doubling, and hiding, not in speed. Her entire life may be spent within an acre thicket. Yet in our times she has followed the plow the length of Michigan and into Ontario where before she was quite unknown.

The cottontail has two southern cousins that have taken up peculiar lives. Both have shed the strong dislike of their widespread relatives for water. These forms are known as the swamp rabbit and the marsh rabbit, the latter being the more aquatic of the two, while the "cane-cutter" of the swamp is twice the size of his better swimming neighbor. The swamp rabbit takes to water when pursued, but the marsh rabbit with spreading toes and short-haired feet may seek the water for

sport alone. There where it is eight feet deep he frolics in the moonlight. When a hunter frightens him he lies submerged among the lily pads with only eyes and tip of nose in air,—so confident in the efficacy of his concealment that it is said he sometimes lets himself be touched before striking out for home in greatest haste.



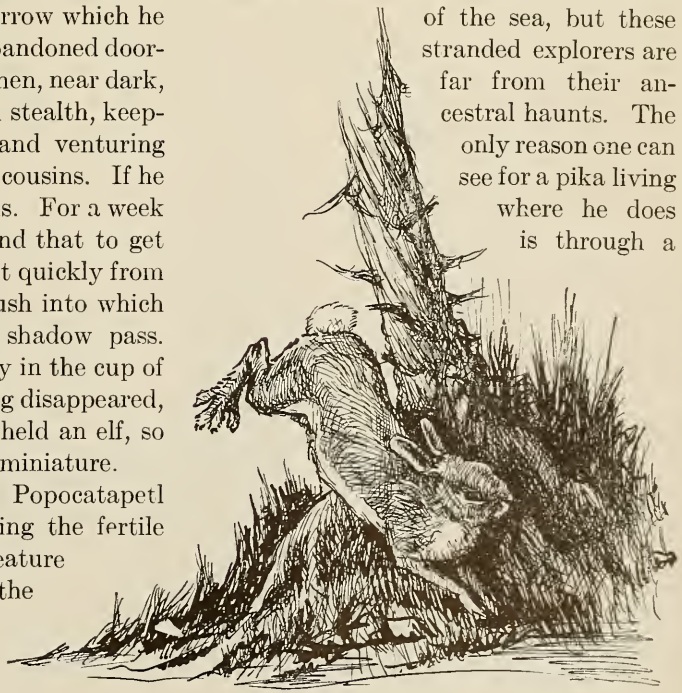
SILENT WINGS

A drop of rocket speed, and the large toll of rabbit lives taken by the larger owls is increased by one

In a small region which embraces corners of four states and within the haunts of jacks and cottontail, lives the tiniest rabbit of all, the pygmy, as he's named in books. Few know this rabbit, for his range and population are in proportion to his size, and of all our group he is the most private in his life. From early morn until sunset he hides within a burrow which he himself has dug, or in the abandoned doorway of a badger's home. When, near dark, he ventures forth, it is with stealth, keeping close to mother earth, and venturing none of the high hops of his cousins. If he is seen, it is by no wish of his. For a week I hunted him and then found that to get the pygmy, one had to shoot quickly from the hip or blindly into a bush into which one had seen a pygmy's shadow pass. But, when the limp form lay in the cup of my hands, the joy of hunting disappeared, and it seemed as though I held an elf, so perfectly was he a hare in miniature.

High on the slopes of Popocatapetl and Iztaccihuatl, overlooking the fertile Valley of Mexico, lives a creature that, though not taking the place of the smallest of our rabbits, truly is the most extraordinary. With short round ears, and no tail at all, this rabbit looks most like a pika, but in form, in color and in texture of its pelage, the resemblance better fits a meadow mouse. Like the meadow mice, this rabbit builds and uses well marked runways and tunnels in the long dense grass in which it lives. We hope that these volcanoes stay quiescent or that the species spreads its range, for such a creature should not pass into oblivion until it is better known.

The pikas, which have many pseudonyms, including that of coney, rock-rabbit, and hay-maker, do not live near to man, but in this country spend their lives along the edges of the talus slopes, usually high up in the mountains. Some colonies live in broken lava fields not far above the level of the sea, but these stranded explorers are far from their ancestral haunts. The only reason one can see for a pika living where he does is through a



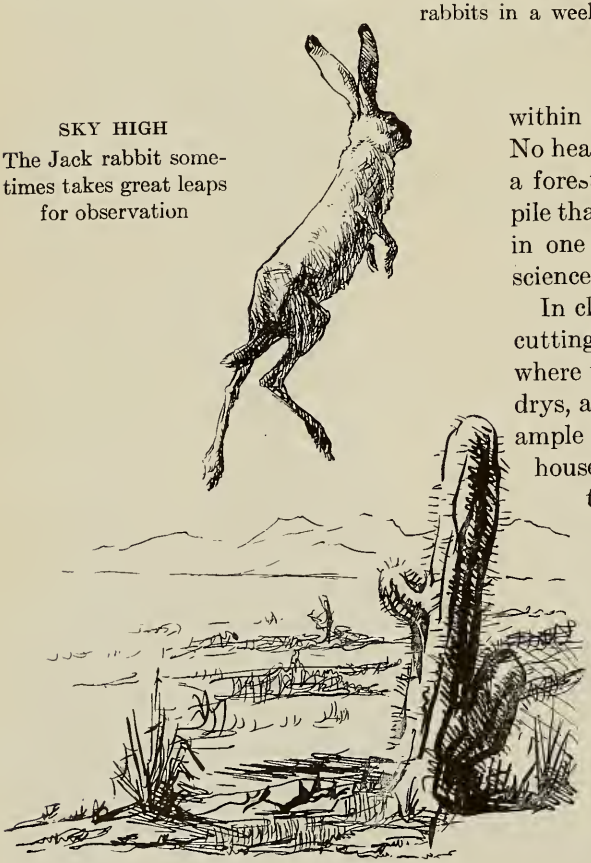
preference for solitude. Occasionally he has a neighbor in a whistling marmot. Porcupines sometimes den near him. Hungry coyotes vainly stalk him, and hawks swoop close in search of an unwary individual. Once while I was seated patiently with gun on knee, trying to see some of the dozen pikas that were calling near me, a hush fell suddenly upon the rocks, and then I saw a long brown weasel hastily cross the length of the slide, himself intent on the same game as I. But neither he nor I succeeded there that day.

Do not search for these evasive creatures near the center of a large expanse of rock, for they must feed, and their food lies not within this great débris, but at its edges. No heap of rock is too small for them. In a forest I have heard a pika call from a pile that a driven prairie hare could cover in one leap. This pika gave himself to science.

Photograph by J. H. Batty

BABIES OF MEXICO

Born as hairless and as helpless as a human baby, these rabbits in a week can hop about and play with evident enjoyment



SKY HIGH

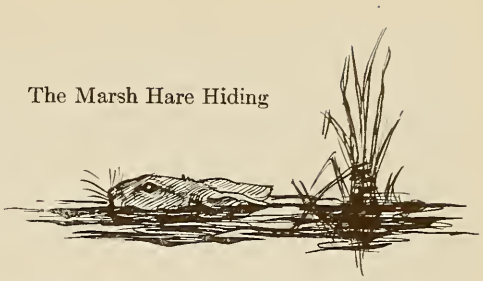
The Jack rabbit sometimes takes great leaps for observation

In clear weather pikas busy themselves cutting hay and carrying this to a spot where the sun will reach it. Here the hay drys, and, when the snow comes, provides ample food for the pika in his vast playhouse underneath the snow, while above, the improvident rabbit often starves. The rabbit kind were given no defense and little brain. Theirs is the rôle of changing grass to flesh for the delight of carnivores and man. Their only hope is in their fleetness and ability to hide, which, coupled with a fecundity notorious, has given them ascendency. Foxes, wolves, dogs, and coyotes, cats of many kinds, relentless weasels and their kin, hawks

and owls, snakes and man, all pursue and kill, and yet the rabbits do increase until a plague sweeps through their ranks, or famine brings them back to their proportionate share of nature's bounty. Man sometimes grows impatient awaiting the inevitable, and, in a single day of beating a great rabbit country toward a corral, will take a toll of twenty thousand lives. Thus they do things in California. But the hares need little time to refill depleted ranks, and one soon hears again of a farmer's haystack being completely devoured by the hungry hordes.

The life span of a hare has been known to reach a dozen years, within the confines of a cage. In nature, five no doubt would be exceptional. Faltering faculties make a creature in the wild an easy prey to all the hunting world.

If silence is a virtue, the rabbit is a leader in morality. Though equipped with vocal chords, the rabbits more commonly communicate by rubbing whiskers or by



The Marsh Hare Hiding

stamping. As yet no one has learned their code, but there can be no doubt of their intentions. A tame rabbit on a tambourine may be taught to talk in this first sign language at request. In terror rabbits do forget their manners and shriek a loud and pitiful *quaa - a - a - a - a* but they rarely utter other sounds.

Bearing out the attestation of good character that his silence shows, we note the rabbit almost never winks. But watch his nose and lengthened whiskers tremble! Winking is but a safety valve for nervous energy that finds an outlet in such small movements as in rolling eyes, twitching nose, or chewing. The rabbit finds relief in his moustache.

The lagomorphs are known as rigid vegetarians, and for the better part this is true. Yet, with the placidity of a scorpion the buck will eat its new-born young, at least when he is in a cage. Northward, the hares sometimes gnaw the frozen carcasses of their own kind, or on occasion, other meat. Fresh blood, however, is known as a most successful repellent wash when used on fruit trees. A strange defence against a cannibal!

Why is it that the rabbit will not bite? In handling even the largest and most protesting bucks one only needs to guard against the sharp and ripping claws. No provocation induces

Photograph by G. H. Sherwood

CONFIDENCE

These youngsters, born within a shallow fur-lined cup on a New England lawn, show no fear of their gentle captor but only bury their noses in the shade to escape the brilliant sun

them to use their teeth that look so dangerous. In fighting among themselves they use their teeth as well as claws, but towards a stranger never take the thought.

Speed is an attribute of prairie and of desert living creatures. Of our mammals, the pronghorn is the swiftest, but now that the pronghorn is all but gone the prairie hare holds honors. There is a saying among the cowboys that one has a good horse if one can follow a jack rabbit so fast and so far that it is forced to lay down its ears. Thirty miles an hour is perhaps the best the hare can really do. The polar hare hops along on his two hind feet as does a kangaroo, but gains no speed by it.

Man has long esteemed the flesh of rabbit. There are evidences that before historic times he took the timid hare with arrows, and by snaring. In Rome's ascendency the Hippodrome was converted into a small forest and stocked

FELD HASE

From the drawing by Albrecht Durer

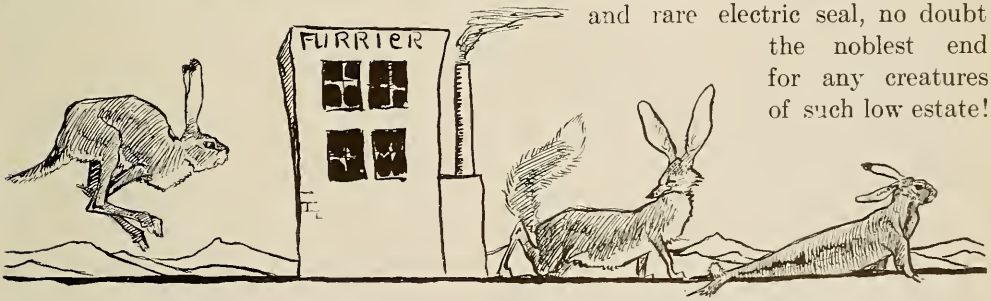
Courtesy U. S. Biological Survey

CATCHING RABBITS WHOLESALE

This old picture from California shows the end of a "rabbit drive." Because of the damage done to their crops, the farmers often organized these drives, thus corraling and killing thousands of the creatures

with rabbits, hares, and other game. The people then were given entrance and every person was allowed to retain the animal which he or she could seize and carry home. *Civet de lièvre* and hasenpfeffer may justly stimulate the palate of those that know them, and among some groups in Italy the meat of the domestic hare is the only one that supplies the table in ordinary times. The rabbitries do less well here.

Felt, jujube, gelatin, and glue have long been made from rabbit hides, while now our clever furriers have found it feasible to do what nature couldn't, and transform the humble hare to Baltic fox and rare electric seal, no doubt the noblest end for any creatures of such low estate!



MARCO POLO'S SHEEP

Collecting *Ovis Poli* in the High Pamirs. An Account of One Phase of the Morden-Clark Asiatic Expedition of The American Museum of Natural History

BY WILLIAM J. MORDEN
Field Associate in Mammology, American Museum

THE snow fell steadily, blotting out every feature of the Pamir landscape. The peaks that rose about us were lost behind the falling curtain of white, and the details of the landscape were completely obscured. Through the numerous openings in the roof of the native "yurt" that had been loaned to us, the snow fell to the floor, melting near the fire and accumulating in tiny pyramids near the felt-covered wall.

We had been on our way for thirty-five days, and now were actually within Russian territory, high in the valleys of the Pamirs—actually camping on "the roof of the world," in the region that is the natural home of *Ovis poli*, which we had come to find. We had struggled over the Burzil Pass from Kashmir, had crossed the Himalaya through Gilgit and Hunza with sixty coolies carrying our belongings, had crossed the snowy Karakoram into Chinese Turkestan, and there, close to the Russian border, below the notch of Peyik Pass, had camped and sent a messenger with our various papers over to the Russian army post of Kizil Rabat in order that we might be assured of a friendly welcome in that remote and jealously guarded military territory.

Nor had we been certain as to the kind of a reception that we might expect. Stories of the most discouraging kind had been told to us by our interpreter, and by the natives with whom we had come in contact. We had been assured that the best we might hope for was arrest and deportation, and that our belongings would most certainly be taken from us. But we had letters from various officials—Russian and others—and even had a special permit from Moscow, so we persisted. But we were not certain, despite our Moscow permit, that the guardians of this distant Central Asian outpost had been notified of our coming, and consequently could not tell just how they might decide to welcome us.

But now, as we sat about the smoky fire of yak dung, and tried laboriously to converse with the Russian captain who had been assigned to us as a sort of companion, we were very much at peace with the world. The Russians at the army post had received us in the most friendly manner possible. We had actually seen a herd of thirteen *Ovis poli* rams within an hour after we had crossed the Russian border, and now, save for the snow-storm, we were ready to begin the work that had led

us to that distant and rarely visited portion of Central Asia—we were ready to begin the collection of a series of *Ovis poli* for The American Museum of Natural History, before marching to the east and north to carry out our other plans in Chinese Turkestan and in Mongolia.

Thus it was that we sat about the fire and conversed, through a series of three interpreters, with the youthful captain who had come with us to our camp where it was located ten or twelve miles inside the Russian border, and fifteen miles or so from the Russian army post at which our official reception had taken place.

We were anxious, of course, to be out along the ridges in our search for the poli, and we peered forth periodically at the clouds, hoping to see them clear away. For three long years I had been planning for this very time, and I was impatient at being held up by a snow storm now.

I had fortunately been able to interest Dr. Roy Chapman Andrews in my plans, and through him President Henry Fairfield Osborn of The American Museum of Natural History had become acquainted with them and had been good enough to detail Mr. James L. Clark, of the Museum staff, to accompany me. And now that Clark and I were actually on the ground—now that we had seen, on the distant slopes, a beautiful band of the supposedly rare animals that we had come to find, we found the little delay caused by the snow storm unduly trying and prolonged.

The smoke of the fire half filled the *yurt* that had been set up for our benefit, and the much translated conversation with the Russian captain grew less and less interesting. We smoked and stirred the fire. We rolled up in our blankets as night fell and awoke to find the snow still falling. But finally, about noon, the

BURDEN BEARERS OF THE PAMIRS

Porters and yaks of the Morden-Clark Asiatic Expedition among the snows of Central Asia. In order to hunt among the Pamirs the yaks were almost essential

storm began to clear away. The late afternoon was perfect, and the atmospheric clearness, when the sun shone, was amazing. Hills near camp, probably five hundred yards away, looked as though one could throw a stone to them, while distant mountains stood sharply cut against the sky. Fresh snow lay everywhere, whitely softening the sharp contours of rocks and hills.

The ending of the storm gave us our first opportunity to hunt, so we arose at three-thirty next morning, by the light of a pale last-quarter moon. It was bitterly cold, for we were camped at an altitude of fourteen thousand feet. All our fuel, too, was wet, and the little fire that tried to blaze in the middle of the yurt was mostly smoke. We hurried into frozen clothes and ate a hasty breakfast which cooled as rapidly as it was brought from the cook *yurt*. Before daybreak we were on our yaks, ploughing through deep snow up the valley. There was no wind at first, but the still air was icy and the temperature was well below zero. The sun, which reached us about six-thirty, did not moderate the cold for at least an hour.

Shortly after sunrise, a band of thirty poli ewes on a hillside ahead caused a halt, and the Eyemo camera was set up and some motion pictures made with a telephoto lens. Several ewes came to within about two hundred yards of our position, stopping now and then to stare at the dark objects below them. We were able to get some excellent motion pictures, the first ever made of live *Ovis poli* in their native range. These, with other motion and still pictures obtained later, made a series which supplemented the specimens and added to their scientific value.

RUSSIAN SOLDIERS STATIONED IN THE PAMIRS

These men received Mr. Morden and his companion cordially, and made every effort to assist them in their arduous hunt for *Ovis poli*. Mr. Morden is on the right of the picture and Mr. Clark, the assistant director of the American Museum, is on the left

ON THE LOOKOUT FOR *OVIS POLI*

Telescopes were essential in hunting the wary animals. Only by locating them at great distances, and stalking them very carefully, could they be approached at all

Several rams were sighted on a ridge across the valley about a mile ahead and we at once stopped to examine them from the protection of some jutting rocks, though they were very far away for a detailed view. Soon, however, they came down hill in our direction and passed out of sight behind a ridge. Just as we started forward, they reappeared and moved leisurely upward again, while twelve more rams came down from our side, crossed the valley and joined them.

The whole band went about half way up the snow-covered slope, and began to paw through to the grass beneath. The snow was about two feet deep, but they seemed to have little difficulty in travelling or in reaching through it to the ground. They were a wonderful sight, those twenty big *Ovis poli* rams; I do not suppose there were horns in the lot which measured less than forty inches.

About noon the rams arose one by one, pawed about for a short time, and then casually followed a leader along the slope over a ridge. Immediately the last disappeared, we hurriedly collected our belongings and were off after them. It was a long breathless climb through deep snow but we finally reached the ridge over which they had crossed. While traversing a long slide of broken rock, I noticed a pair of horns outlined against the snow on a ridge some two hundred yards ahead. Glasses showed one of the rams lying among rocks, with another just above him. As we watched them, they suddenly saw us, probably alarmed by movements of the native camera-carrier, who tried to crawl upward. They arose at once, of course, looked for a moment, then dashed upward. When we arrived at the ridge, the whole herd, which had been lying among the rocks of a shallow depression, had dis-

appeared over the next ridge. There was nothing to do but return to the yaks and make for camp, as a snow-storm had started which promised to become thicker as darkness approached. So ended the first day's poli hunting, with some knowledge gained but no specimens collected.

Snow, which precluded any possibility of hunting, continued all night and much of the next day, which we spent in camp. One more day was spent hunting from that camp but the snow was so deep that we could accomplish little. Twenty-two rams were located and examined through telescopes; one, estimated as being fully fifty five inches, was shot at long range and found to measure but fifty two inches around the curl of the horns. Experience in judging sheep heads is of little use when hunting poli, we found. I had thought that I was a fairly competent judge of wild sheep horns, as I had previously shot seven species in North America and Asia, but I discovered that the wide sweeping curl of the horns of Marco Polo's sheep is very deceptive. British sportsmen who have hunted in the Pamir region have met with the same difficulty.

Deep snow and daily storms made it advisable to move the scene of our hunting farther into the country where, according to reports, we would find poli more plentiful and would not be handicapped by such deep drifts. A two-day journey took our small caravan past the army post at Kizil Rabat to Ak-tsoi, a district of the "Little Pamir" near the Afghan border. On the way we stopped for a short visit with the Russian officers, who very thoughtfully sent messengers ahead to some native camps, so that *yurts* might be ready for our use. The commander asked how many poli we wished to shoot. Receiving our reply that ten would

MR. MORDEN ON HIS STEED IN THE PAMIRS

Yaks are surefooted, phlegmatic animals, that are given to stubborn spells that no amount of effort seems able to overcome. On one occasion a balking yak had to be left on the trail, where he remained without moving a dozen feet for three days, when one of the natives brought him into camp

OVIS POLI HORNS

Throughout the Pamirs the horns of dead poli are occasionally to be found scattered about. The natives kill large numbers of them, but, of course, have no use for the horns, and consequently throw them away. Sometimes, too, many of the animals die during unusually hard winters

probably be sufficient, he seemed surprised and suggested that we had come a long way, spent much money and endured great hardships for such a small number. His idea that a hundred *Ovis poli* would be about the proper number amused us, though it was cheering to learn that the animals were plentiful.

As we approached the site of our new camp at Ak-tsoi there appeared, high on the mountain just behind it, two bands of poli ewes and young. We counted eighty altogether as, stopping frequently to look at us, they went slowly upward.

Several days spent in combing the country around Ak-tsoi, showed us that, though poli were there in large numbers, it was a most difficult district to work. Valleys were open and almost without cover, making long waits necessary to approach herds closely enough even to judge the sheep. Furthermore, we saw no large heads, though some two hundred rams came at various times under our observation. Nor was our campsite ideal, for melted snow was the only water supply and yak dung for fuel had to be brought several miles. So, when the Kirghiz told us of another district, called by them Dung-gelduk, two marches away, we decided to move again.

The first three or four miles of the trail from Ak-tsoi was up a wide valley in the midst of a white world where snow covered everything to a depth of fully two feet. Just before leaving the snowy valley for a smaller and more rocky, but less white one, eight poli were sighted. One of them proved to be interesting, and a sharp dash across the valley brought us behind a steep little ridge, up which we trudged on foot. But we made the mistake of not following the sheep-hunter's maxim, "when in doubt go to the top,"

SEARCHING A VALLEY FOR *OVIS POLI*

As with other mountain animals, *Ovis poli* tend to escape from their enemies by leaving the valleys for the crests of the mountains. Thus the hunters made it a point to scale the mountains very early in the mornings, in order to lie in wait for them there

and found ourselves suddenly looking eye-to-eye into the face of a small ram. He wasted no time trying to stare us out of countenance but joined his friends, and the eight began to make sheep-tracks. I was able to stop the last one, which, while carrying horns of but fifty inches in curl, gave us an almost undamaged complete skeleton, a necessary and welcome addition to the collection.

Our Kashmiri staff and the pony-men, being Mohamedans, were constantly asking us to shoot many *poli* and to allow them to cut the throats and so make *hallal*, without which no true believer may eat the meat. But as I had previously had experience with *hallal* in Kashmir, when some specimens were ruined by having the necks badly slashed, I refused permission for any of our men, except the head *shikari*, to touch the animals, and promised to buy the staff some domestic sheep at the next Kirghiz camp.

Following our packtrain, we reached a wide valley where we found a *yurt* ready for us in a large Kirghiz camp of five families, surrounded by herds of sheep, yaks, and camels, and as usual, many snarling dogs.

When we wished to buy two sheep, we were asked twenty-five rupees each and were told that in the city of Andikan sheep cost from fifty to sixty rupees each. Yaks were said to be worth about a hundred and sixty five rupees each. At that rate, all the people around there were rich. We heard a tale of five men who got together ten *lakhs* of rupees (one million rupees) and bought sheep and yaks on speculation. They drove the animals to Andijan and sold them at a comfortable profit. And those were the people to whom one was supposed to give *bakshish!*

Next day, two *yurts* for our use were

dismantled and loaded on four protesting camels, which were added to our caravan of twenty ponies and six yaks. A march of about ten miles brought us into the long narrow valley locally know as Dunggelduk *Jilga*. Just after entering the valley we saw fifteen poli on the hills and while we were looking for a campsite, a band of thirty ewes and young appeared about a mile beyond.

The day after our arrival at Dunggelduk, Clark and I went with three natives to look over the nearby country. About a mile up the valley, one of the natives spied something far ahead. Through glasses, we made out a large bunch of sheep, so we left the yaks and crawled to a little rise. There were thirty-eight rams, of various ages and sizes, in the first lot, with several herds in the further distance, totaling, altogether, fully one hundred *Ovis poli* within our view. We decided that we should back trail and cross a deeply snow covered summit behind the sheep, in the hope of getting above them.

We walked up a sloping fan, and stopped among some large boulders to have another look at the rams. At first they could not be located. Then we discovered that the herd of thirty-eight had split: eight had descended to the frozen stream bed while the remainder had climbed higher up the slope. We cached ourselves among the rocks, while the eight rams ascended the opposite side of the valley, fed a bit, lay down, got up and slowly worked upward but slightly towards us. They finally lay down in an exposed position and we began a vigil that lasted from just after daylight till midday. One person was always on the

A FINE MALE POLI HEAD

The largest head collected by Mr. Morden carried horns that measured 57½ inches around the spiral, and very few were seen with horns so massive

IN A HIGH PAMIR VALLEY

The whole district of the Pamirs is above the tree line, with the result that the region seems singularly bare and forebidding

lookout at the fifty power telescope. The rams lay among rocks and snow, and one showed a head which seemed to have a remarkable curl, even though we had long since become skeptical regarding first impressions of poli horns. "Colonnas," the Turki word for big, seemed to be frequently used in conversation between the natives, so we had hopes, though disappointments had made us want to read the tape before passing judgment on a head of Marco Polo's wild sheep.

The usual daily storm came up the valley and when the snow squall grew more dense, we chanced a move. At the bottom a projecting spur hid us, so we mounted our yaks and hurried across to the further protection of other ridges. We continued about half a mile, at last leaving the yaks tied, or rather anchored, to bowlders, and crept forward and upward over broken rocks and snow. During a short halt for breath, we discovered that the rams had arisen and were coming across the slopes in our direction. We hurried onward to some large bowlders near the edge of a dry wash which gave an opportunity for concealment. While one of the men was carefully scanning the upper slopes I happened to look past his shoulder and was startled to see three white rumps not over forty yards away. I nudged one man, "shushed" the others who were just behind, and we watched the three rams. Unfortunately I had "frozen" in a most uncomfortable position, but there was no chance to shift as they leisurely fed down toward us. One passed out of sight not over fifteen yards away. Marmots were whistling in the valley and this danger signal frequently caused the rams to jerk their heads erect. None of the three had big horns, though one of the natives tapped my foot and

made motions that the lower one was very large. That is one trouble with local *shikaris;* be they ever so good hunters and stalkers, when they get close to game, every head is a big one.

How long we lay within thirty yards of the three rams, would be hard to say. It seemed a long time to me, for though intensely interested, my cramped position took much of the joy from the situation. At last I thought there was a chance to shift slowly, while all three had their heads down feeding. I eased over, moving my rifle as I did so. This brought me facing uphill, a direction in which none of us had been looking. Not over twenty-five yards away stood a big ram, which none of us had seen, staring fixedly at the strange objects below him. I was quite as startled as he, but managed to keep some of my wits about me. His horns at that short distance looked huge. As I gradually swung around facing the big fellow, he jumped and dashed up the hill. There was a momentary glimpse of several other great heads and then all disappeared. Luck was with us, however, for the rams, true to their instinct, ran directly uphill away from the source of danger. They made a glorious picture as they bounded over the snow, but we had little time at the moment to admire them.

We followed breathlessly, and at the crest we saw them again. One of the natives, excitedly using the glasses, indicated that the leader was the largest. It was a very simple shot, not over fifty yards. Another was easily accounted for; two hurried shots were misses but the fifth brought down the third ram. We

JAMES L. CLARK, WITH A FINE HEAD

Of the two finest heads obtained by the Morden-Clark Expedition, Mr. Morden secured one and Mr. Clark the other. The difference in size between them was very slight. When the Russian soldiers were told that the object of the expedtition was to collect *Ovis poli*, they expressed surprise when they were told that about ten specimens would be enough. They felt that having come so far, the expedition could hardly be satisfied unless they obtained a hundred

watched the last, which was thought to be smaller than the others, until he neared the top. Suddenly the man with the glasses whispered that this one had a head fully as large as the first and we were fortunately able to stop him just as he was disappearing behind a ridge. All were within a hundred and fifty yards—a rare bit of luck which gave us four excellent specimens, the finest we had seen.

The first ram proved to have the longest curl—57½ inches, with a spread of 41 inches and a base of 14½ inches. He was ten years old, according to the record of the annular rings of his horns. Though his horns were slightly longer than those of the other rams, which were 56½, 55, and 56 inches, respectively, they measured less around the base. The others were noticeably heavier, the largest being 16½ inches.

From experience gained in measuring many old heads, from study and observation of fully a thousand living animals, and from the specimens collected by us, we came to the conclusion that the present average length of adult *Ovis poli* horns is about fifty-two inches. Doubtless there are many living poli with horns of much greater length; very possibly a world's record now ranges somewhere among the secluded valleys of the Pamirs, but both Clark and I are thoroughly convinced that during our month we saw none larger than the 57½ inch heads we obtained. From examination of old heads and of those collected, our judgment is that sixteen inches is nearly a maximum base measurement; probably an average circumference would be about fifteen inches for fully grown rams.

In general, the horns of *Ovs poli* form an open spiral, extending widely from the face and making more than a complete circle. Usually they are not "nipped in"

LOADING UP FOR A POLI HUNT

The patient yak in the foreground is anchored by his nose rope to a bowlder, and normally is perfectly willing to remain thus tied for hours at a time, even through a snow storm, against which he is amply insulated

A PERFECT PAIR OF HORNS

Despite the great size of the horns, the poli is not a particularly muscular beast, and although it lives among rocks and dangerous ridges, its bones are light and comparatively brittle

at the bottom of the first curl, as are those of *Ovis ammon ammon*, their cousins of the Altai mountains. There were exceptions to this rule, however. Several specimens were observed to carry horns of the same type as those of *Ovis canadensis* of North America. One old fellow, whose right horn was broken about level with his face, had the left curving close to his cheek and up past his eye, with a curl much like that of a big Alberta ram. Others had the horns nipped-in close to the face with the wide flares typical of the Altai sheep.

All the sheep collected were in excellent winter pelage, their heavy coats making them appear larger than they really were. In early morning light and at a distance, poli appear creamy white with brownish saddles. Closer examination confirms the first impression except that between the white and brown there is an intermediate grayish tinge which blend the two and runs up the back of the neck. The gray fades out just back of the horns, where the hair is almost white. The horns are yellow-white, much the shade of old ivory. In bright noon-day light, when the mirage makes all objects at a distance indistinct, counter shading will sometime cause a band of *Ovis poli* to become almost invisible against slides of broken rock not over two hundred yards away.

Summer coats, which are those most often seen on the specimens obtained by hunters, are short and differ somewhat from the winter pelage. The real winter coat can be seen only on specimens collected in the winter or early spring. We were most fortunate to be able to complete our work before the summer shedding began; it was just starting when we left the Pamirs.

The Pamir sheep are surprisingly

lightly built and their bones are very delicate for animals living in rugged country where travelling through deep snow is necessary during much of the year. Clark said that poli bones were more brittle than those of any other wild animal he had handled. Neither are these sheep exceptionally muscular, no more so, in fact, than the Virginia deer of North America. The necks of the rams seem lightly built for the carrying of such heavy heads. A carefully weighed ram totalled two hundred and thirty nine pounds, though in the fall he would probably have weighed from twenty five to fifty pounds more. There was practically no fat on any of the specimens we collected in the Pamirs; all were very thin, with ribs showing noticeably.

The lives of the poli must be made miserable by the great number of parasites infesting them. All adults collected by us had quantities of grubs under the skins; sometimes large areas, especially along the back, would be found perforated by the repulsive looking insects, and the hair would be quite loose at those points. Grubs were found in the noses of many specimens and all were infested with ticks. The ticks probably caused the frequent rubbing against rocks which we noticed.

In the springtime the rams herd strictly by themselves and large males usually keep together, with sometimes a few youngsters of two or three years tagging along. We only once saw a band of rams with a yearling in it; the little fellow was so small he looked like a ewe, but he bore himself with all the masculine assurance of a youth out with his elders. Large herds of ewes and yearlings were common during early May, but about the twentieth the ewes became scarce and the yearlings were seen in groups by them-

A FEMALE POLI HEAD

It was difficult for the hunters to tell the difference, at great distances, between the females and the younger males. Closer inspection of the two shows that the horns of the young males tend to be slightly heavier than those of the females, but the differences are not obvious at several hundred yards

THE DESOLATE "ROOF OF THE WORLD"

Although the peaks of the Pamirs sometimes reach as high as eighteen or nineteen thousand feet, they do not give the idea of great size, because the altitude of the valleys is so great. Whole sections never drop below fourteen thousand feet, and most of the valleys appear more or less desert-like, as this picture shows

selves or with one or two immature rams. We first saw new-born lambs on May twenty-fourth, then in increasing numbers. The ewes probably seek secluded places among the peaks at lambing time, which would account for their scarcity at that season.

The first young lamb was pretty wobbly on its tiny legs and the solicitude shown by the mother was very touching. We first sighted the ewe from a distance and were attracted by her strange actions. She appeared lost, for she walked uncertainly forward, stood to gaze back, and then returned a little way, apparently to feed. It was only when we looked carefully with the telescopes that we could distinguish the tiny dark gray form of the lamb stumbling along after its mother. Later, when we tried to capture one of the youngsters, we found that they attained surprising agility in a few days.

The spring diet of the poli is apparently limited. Here and there among the rocks grow tiny bunches of grass with wire-like leaves, and about the middle of May a variety of wild onion appeared in sandy areas. We saw the sheep pawing through the sand to obtain the first shoots of the onion which had not yet reached the surface. That these form a considerable portion of their spring forage was attested by the odor of the animals and the strong flavor of their meat. Later in the season there is probably more grass among the hills; when we left the Pamirs in early June a greenish tinge was becoming noticeable, particularly on the more sandy slopes.

Roughly, the range of *Ovis poli* may be said to extend from the Thian Shan Mountains on the north, south through

the Pamirs to the Valley of the Oxus, usually at an altitude of from twelve to eighteen thousand feet. In Chinese territory a few poli are still seen in parts of the Tagdumbash Pamir, but whether through years of hunting or other causes, this section is now almost devoid of them. On the west they are said to extend to the limits of the Pamir region; in other words, they are found practically everywhere in the Russian Pamirs. Though we hunted and traveled through a considerable territory in actual area, we saw but a small portion of their range.

Some zoologists consider *Ovis poli* as a race of *Ovis ammon;* other authorities place *Ovis poli* as a separate species of the genus *Ovis.* But such problems must be decided elsewhere, for it is not the province of this article to enter the field of technical discussion.

Back and forth across the ridges and through the high valleys of the Pamirs we hunted for a month. We studied poli through our telescopes. We stalked them along the rocky slopes. We photographed them, and now and then collected some specimen that seemed to be what we wanted for the Museum collection. We were fortunate in finding another fine ram with heavy horns which measured 56½ inches; we added a two-year-old ram, a ewe, and two yearlings to the collection. And then Clark brought in a magnificent ram, whose splendid horns measured 57½ inches around their graceful curl. It made a fitting climax to our work in the Pamirs.

During our hunting we definitely found that these beautiful, spiral-horned sheep are not the rare and almost extinct animals that they had been thought to be. We actually counted a thousand and fifty two rams and more than six hundred ewes, and in these figures a generous allowance was made for possible duplication. Furthermore, we included none that were not counted either by Clark or myself. Many bands were reported by our native hunters, but these we did not count.

It is next to impossible to make any accurate estimate of the number of *Ovis poli* that remain in the Russian Pamirs, but certain it is that they are very far from extinct.

CAMP IN THE PAMIRS

The hut in the foreground is a *yurt,* which is a collapsible affair used widely through Central Asia. The sides are built of folding rods, covered with felt mats, and the top is supported by poles resting on the sides and about a ring in the center, where an opening is left in order to rid the hut of the smoke of the fire that is built on the floor

A DRAMA OF THE MICROSCOPE

The Microscopic Life Found in One-half Inch of Pond-bottom Magnified One Hundred Diameters or, Cubically, One Million Times.

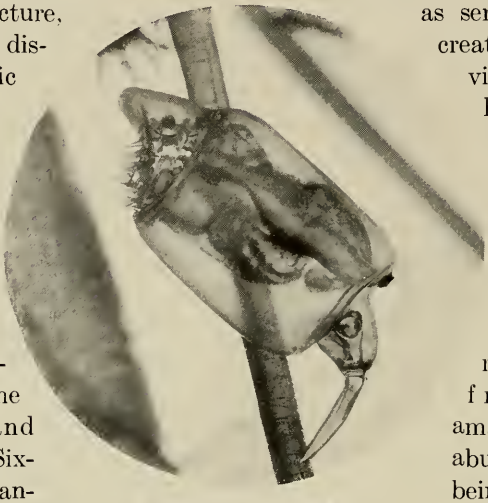
By ROY WALDO MINER
Curator of Lower Invertebrates, American Museum

The new Rotifer Group in the Darwin Hall of the American Museum was designed and directed by Doctor Miner. The field work on which it is based was largely carried on at Mt. Desert Island, Maine, by Doctor Miner in collaboration with Mr. Frank J. Myers, whose intimate knowledge of rotifer anatomy, natural history, collecting methods, and microscopic technique were of inestimable value during the preparation of the group. The field color sketches were prepared by Dr. George H. Childs, under Doctor Miner's direction. The remarkable glass modeling which is the outstanding feature of the exhibit is the work of Herman O. Mueller, of Doctor Miner's staff of artists, and sets a new mark in work of this kind, both as an achievement in skillful preparation of the hundreds of component models, and in the successful assembling into one complex whole of a multitude of fragile parts. The delicate coloring of the models and background is the work of Mr. W. H. Southwick, while those features of the pond bottom constructed in wax were modeled by Mr. Chris E. Olsen.—THE EDITORS.

MORE than three centuries have passed since Zacharias Jansen of Middelburg, in the Netherlands, and his fellow townsman, Johannes Lippershey, produced two little instruments destined to have most far-reaching effects upon human knowledge. Both were contrivances in which crude glass lenses played a most important part. Jansen's invention was the first microscope, and was in use by 1590. Lippershey's was the telescope, which was sold by him in 1609. The following year, Galileo, in Italy, had heard of Lippershey's invention and spent a night considering the optical principles involved. By the next morning, he had reinvented the instrument for himself, and, a little later, adapted it for examining minute objects. Jansen and Lippershey were merely ingenious opticians. Galileo's adaptation of the telescope to astronomical purposes and the remarkable discoveries he made with it have coupled the instrument inseparably with his name, so that he is commonly credited with its invention, and, according to an enthusiastic biographer, with that of the microscope, as well. While all credit is due, therefore, to the two Dutch opticians for originating the telescope and the microscope, it was the genius of Galileo that perceived the significance of the former instrument and by its aid he overthrew for all time the ancient Ptolemaic cosmogony, assiduously fostered by the ecclesiastics of the day, and demonstrated the truth of the essentials of the Copernican theory. From that time on, to all intelligent men, the earth moved around the sun. The world now knew that Jupiter had satellites, that the strange planet, Saturn, existed, and that there were spots upon the face of the sun, the observation of which proved its rotation.

While the microscope was not at first used for the study of natural history, by the middle of the Seventeenth Century, a group of keen observers, including Hooke and Grew in England, Malpighi in Italy, and Swammerdam and Leeuwenhoek in Holland, turned its magnifying power upon hitherto invisible details of animal and plant structure, and the last-named discovered the microscopic world of life.

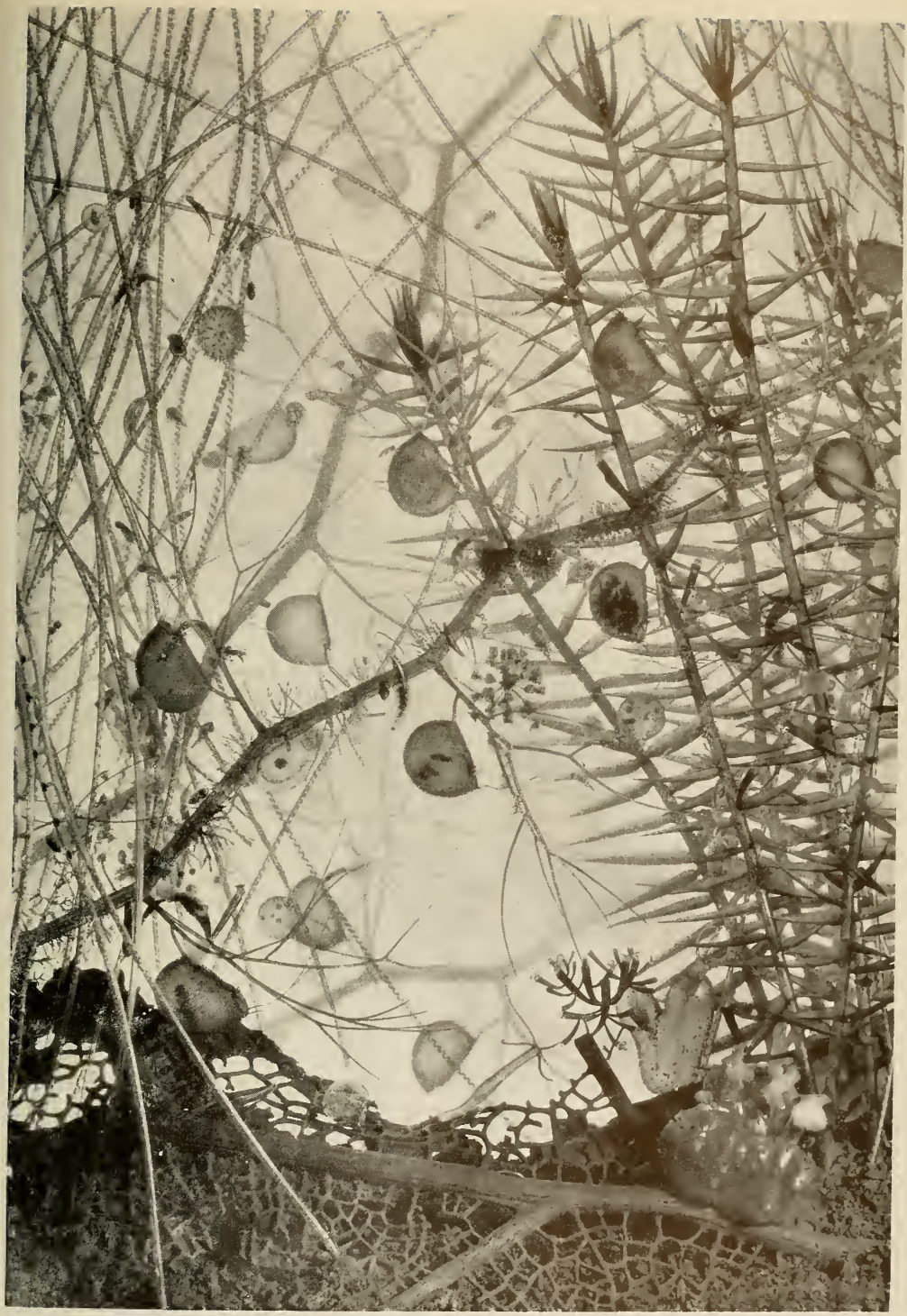
Men had formerly lived in a world bounded by the limits of their unaided eyesight. That which existed beyond was the subject of more or less fantastic surmise. While the mathematicians and astronomers of the Sixteenth Century dimly anticipated something of the truths of the universe outside the range of their visual apparatus, the invention of the telescope and the microscope suddenly furnished glass windows to the practically flat and two-dimensional room in which mankind had hitherto dwelt. Through the one they now gaze up into the starry heavens to see the planets swinging on their appointed courses around the sun. They penetrate interstellar space and comprehend that the twinkling stars are immense suns of other systems, that outside our universe are other unbelievably distant universes dimly shadowed like luminous cloud patches. Through the other window, the microscope, they gaze down into their own world of life, so enlarged by the magic of refracted light rays, that even the minute cells of animal and plant tissues are disclosed to view, as the fundamental units of living structure. In a drop of pond water, Leeuwenhoek saw myriads of minute living creatures, the existence of which was hitherto unsuspected, because invisible to man's naturally coarse vision. These living beings crowd their watery habitat, hurrying hither and thither on the business of life, as seriously intent as the creatures of our larger environment. Leeuwenhoek thus became the pioneer adventurer in this new world, which interpenetrates our own so intimately, and yet, through the accident of size, is so immeasurably separated from us. He was amazed at the variety and abundance of these tiny beings and his writings betray his confusion of mind. His letters, published from 1673 to his death in 1723, largely written to the Royal Society of London, were filled with accurate but yet miscellaneous descriptions of his observations. They were accompanied by a wealth of drawings, remarkably faithful, considering the time in which he lived and the crudity of his instruments. For his microscopes were mostly simple magnifiers, which he ground and mounted himself. He possessed 247 of these, containing 419 lenses, which apparently gave him magnifications of from 40 to more than 270 diameters. They must have been of fine quality, for the most part, judging from his results.



A SAVAGE ROTIFER

Dicranophorus crouching to spring upon its prey. Lightly balanced on its pointed toes, with body contracted, it awaits an unwary victim

Among the most conspicuous of the microscopic creatures that attracted Leeuwenhoek's attention were the animals since known as rotifers, of which he pub-



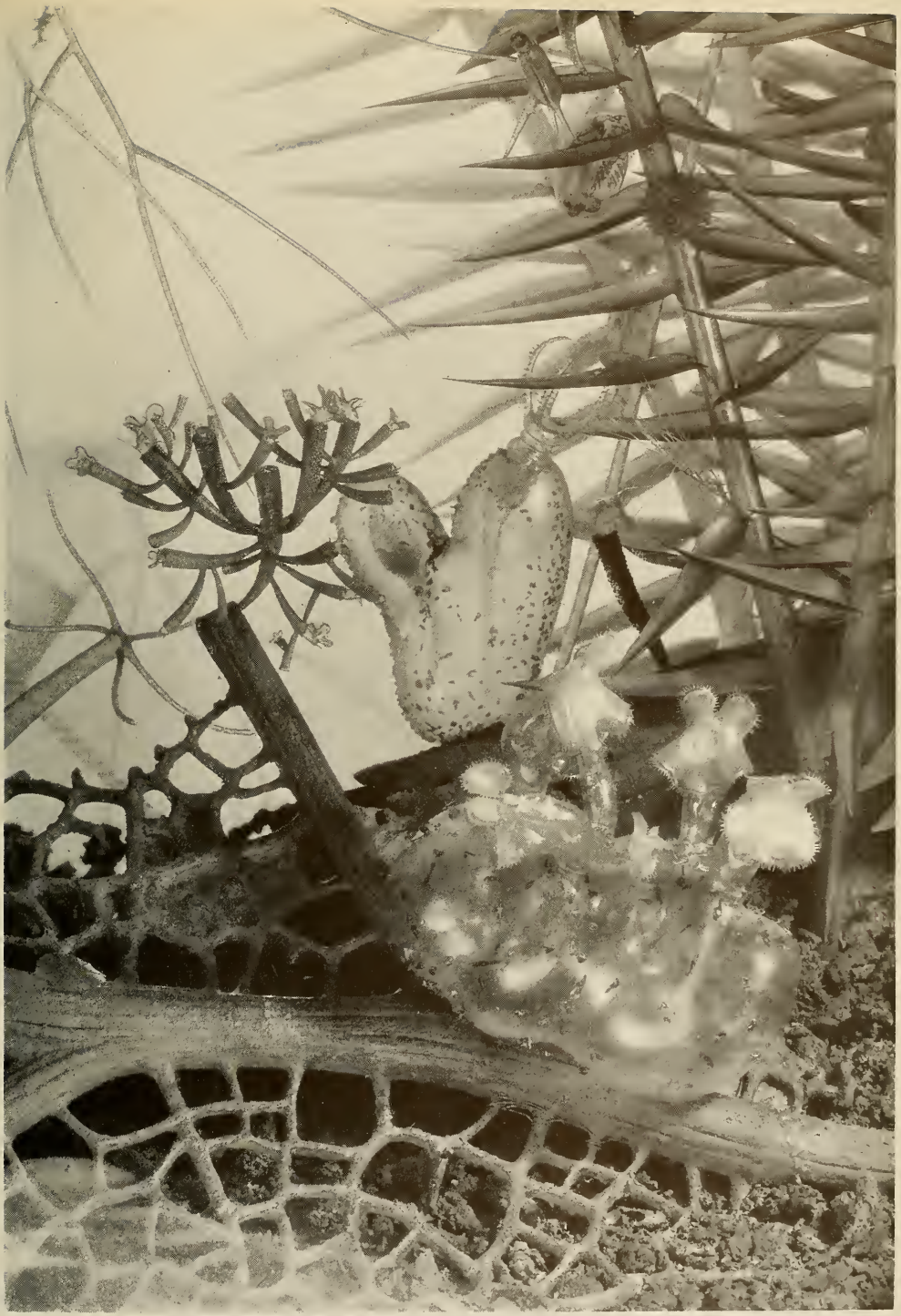
A ROTIFER JUNGLE SEEN THROUGH A MICROSCOPE

The new Rotifer Group in Darwin Hall of the American Museum, exquisitely modelled in glass, represents a cubic half inch of pond bottom magnified one hundred diameters, or, cubically, one million times. A spray of the carnivorous water plant *Philotria* spreads its bladder-shaped animal traps diagonally across the field of view, to snare the microscopic rotifers and other tiny creatures which make up its food

lished descriptions in 1703. A contemporary investigator, the Rev. John Harris, antedated him by seven years in making the first published, but rather vague, description of an undoubted rotifer. Thus, these remarkable inhabitants of the minute world, first recorded in 1696, have been known to microscopists for 230 years. Yet it is quite likely that by far the greater majority of educated persons today have never heard of them, and at the first mention of their name, would immediately ask "What is a rotifer anyhow?"

The new exhibit in the Darwin Hall of the American Museum is intended to answer this question. Rotifers are unknown, simply because of their small size. The new Rotifer Group enlarges a cubic half-inch of their watery habitat, to one hundred diameters, or, cubically, one million times, so that it occupies a space measuring fifty inches, or more than four feet across. The front of the exhibit is constructed to represent a huge magnifying glass, through which the visitor peers into a jungle of water plants peopled by hundreds of tiny animal forms. In their natural size, these plants would cross and recross an area about the size of one's thumb-nail. Here, they are so greatly enlarged that they appear to tower above the observer's head, and their great size gives them a strange and unfamiliar appearance. These and all the other remarkable and complex features of this group have been skillfully modeled in glass to represent the life of a minute area exactly as it appears through a microscope. To the right, a cluster of water thyme (*Philotria canadensis*) rises with slender, pointed leaves and graceful translucent green stems. To the left, and arching also over from the right, criss-cross tangles of *Spirogyra* interweave their slender, tubular strands. When seen in natural size, this plant appears to consist of close tangles of slender silken threads of green, which gather in great masses in still water, and is familiar to us all under the name of "pond scum." It is supposed by many people to render the water noxious. The opposite, however, is true, as the green color of the scum is due to the abundant chlorophyll, which, under the action of sunlight, breaks up the harmful carbon dioxide gas of stagnant waters, utilizing the carbon for food, and releases free oxygen, thus rendering the water purer. In the magnified representation of *Spirogyra*, shown in the group, the strands are seen to be formed of cylindrical cells set end to end, and the green chlorophyll is gathered into spiral bundles (chromatophores), giving the strands of the plant a spirally striped appearance. Hence, the name, *Spirogyra*, is quite appropriate. When two strands of *Spiro-*

A ROTIFER CLIMBING UP A PLANT STEM
With swimming discs folded in and concealed, *Rotaria macrura* hunts for small organisms along a *Spirogyra* stem, advancing like an "inch worm" by alternately arching and extending its body



FLOWER-LIKE ROTIFERS SETTLED IN A NOOK AMONG THE WATER PLANTS

A colony of tube-building rotifers (*Floscularia ringens*) has built a branching cluster of trumpet-shaped "houses" on the edge of a dead, skeletonized leaf. In the center is the transparent, double dwelling of a pair of graceful, comb-armed rotifers (*Stephanoceros fimbriatus*), which are really ingeniously contrived animal traps of voracious habit. In the foreground, the large and unusually beautiful *Octotrocha speciosa* peer out of their jelly-like habitation

gyra come in contact, the cells which chance to be closest send out hollow projections to fuse with those of the opposite strand and connect the cells in pairs. The chromatophore of one cell of a pair thus united, then passes out of it through the connecting canal into the other cell and unites with the substance of its chromatophore, form an oval body, which, after union of the cell nuclei, becomes a spore. This is released into the water and eventually starts the growth of a new plant.

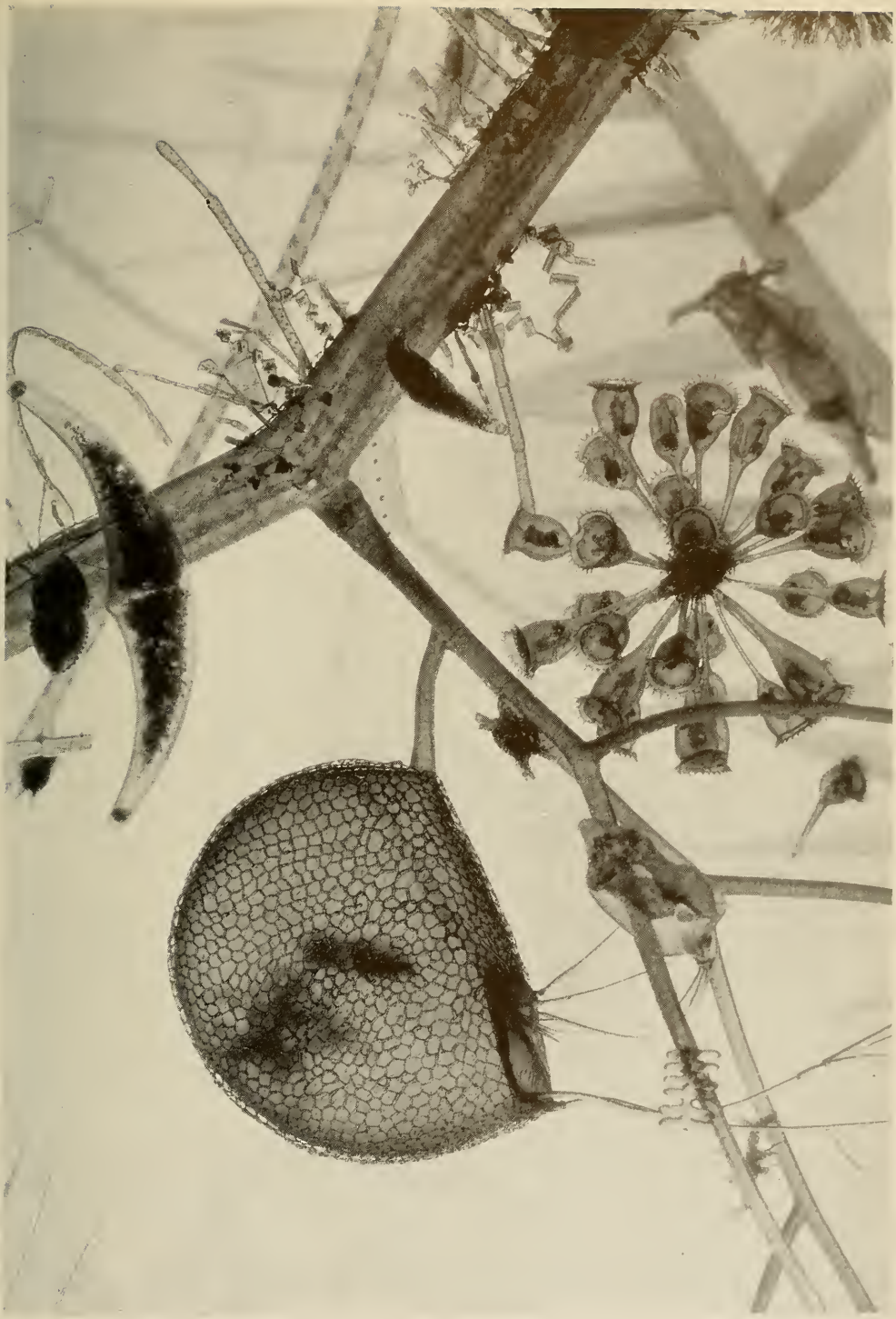
THE TIGER SPRINGS

The *Dicranophorus* darts upon its victim with open, pincer-like jaws (seen at the right), and relaxed and now slender body. This is the same species of rotifer as the one shown on page 502

Diagonally across the center of the group is seen the most remarkable plant of all. This is the bladderwort, *Philotria*. Its stem is slightly zigzag, and, through its translucent walls may be seen the green vascular bundles of the internal structure. Along the stem, at intervals, are slender, branching, spine-like leaves, which, in real life, are very delicate and flexible. From the stem of each of these grows a curious bladder, also called a utricle. These bladders give the name, bladderwort, to the species. From the word, utricle, is derived the former scientific name, *Utricularia*. These utricles are actually animal traps. They are about the size of a pin-head, but are shown here, modelled in glass, about three or four inches in diameter. The tiny animals, with which our microscopic world is swarming, are captured by these traps and, as they die and decay, are absorbed by the plant cells for food. This reminds us of the terrestrial pitcher plants, which capture and digest insects on land. Growing upon the main stem of the bladderwort, we see hosts of minute plants, the unicellular algæ. These are of many varied species, and are so crowded together that they appear like a fine green or brown fluff when seen by the naked eye.

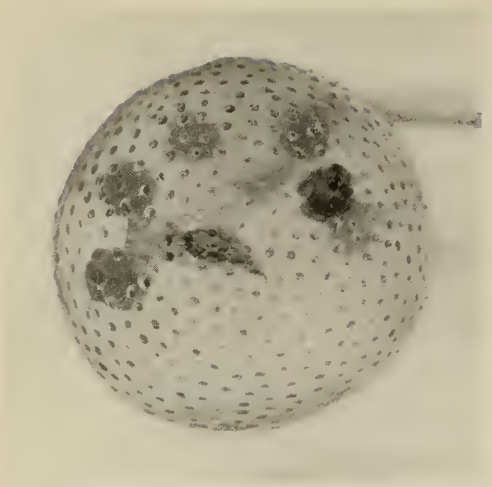
We have examined the vegetation of our microscopic jungle. Let us now become acquainted with its inhabitants, the minute creatures that swim or prowl through its tangled growths or build crystal palaces, in which they dwell upon its branches.

As above mentioned, the most conspicuous of these are the rotifers. The typical rotifer is a somewhat top-shaped animal, that is to say, its body tapers from a relatively large, often flattened head, to a more or less pointed foot, usually furnished with two, likewise pointed, "toes." An excellent description with illustrations was given in a recent number of NATURAL HISTORY by Frank J. Myers, in an article entitled "What is a Rotifer?" (May-June, 1925, page 211.) The head has a crown of cilia, i.e., minute moving hair-like structures. The arrangement of this "corona" varies in different species. In some cases, as in the common rotifer (*Rotaria macrura*), these cilia are arranged in a double row around two circular discs, which are literally borne on the shoulders of the animal, just back of the



A WATER PLANT THAT TRAPS AND DEVOURS MICROSCOPIC ANIMALS

A detail of the Rotifer Group showing a single "utricle" of the bladderwort (*Philotria canadensis*). This, in the living plant, is about the size of the head of a pin. The trap-door is seen at its lower right margin and a captured rotifer is visible within. A spherical, floating colony of rotifers which cling together by their toes (*Conochilus hippocrepis*) is seen at the right. The stem of the bladderwort is covered with tiny, fresh-water algæ, and a crescent-shaped desmid (*Closterium*) shows at the left



A ROTIFER WHICH LIVES INSIDE A COLONY OF PROTOZOA

The spherical colony of the protozoan, *Volvox*, is penetrated by the rotifer *Ascomorpha*, which thereafter lives and feeds inside

mouth-opening and on either side. The cilia lash the water, not indiscriminately, but one after the other in ordered succession. This vibrating movement is so rapid that a wave of motion passes around the discs, giving the appearance of a rotating wheel. Some of the early observers supposed that this was actually the case, and so gave the name rotifers or "wheel bearers" to the animals. They thought that, at last, the principle of the wheel had been discovered in nature, but, with closer observation, it was soon found that this was an optical illusion, and that man still preserves intact as his own invention one of the few mechanical principles not anticipated by nature, namely, that of the wheel rotating upon an independent axis. The rotifer's vibrating coronal circlet of cilia creates a whirlpool in the water, which gathers in still more minute animals, diatoms, and other microscopic particles to be swept down into the vortex where the wide-open mouth is situated. The food stream then passes into a capacious pharynx, to be seized upon by a curious apparatus, peculiar to rotifers, known as the mastax. This is really a set of jaws located in the throat, which differ characteristically in the various species, so that they are used by students of rotifers as a means of identification. In many species, they take the form of toothed forceps that tear the food apart. In others, they act as a grinding mill, and, in still others, as a suction pump. Rotifers of the first sort are active and sometimes prey upon animals of their size or larger. In this case, the rotifer springs upon its prey, suddenly shooting out nipper-like jaws until they project from its mouth, thus enabling it to seize the captive. An example of this is *Dicranophorus forcipatus* (shown on page 506). The second kind, like *Rotaria macrura*, described above, feeds upon very small forms, while those that have suction jaws are herbivorous, feeding upon the contents of plant-cells. For example, *Monommata longiseta* crawls up the filament of *Spirogyra*, cutting a neat round hole in each cell with the tips of its jaws. Then it uses its pumping apparatus to empty by suction the entire

A ROTIFER WITH STRANGE SWIMMING ORGANS

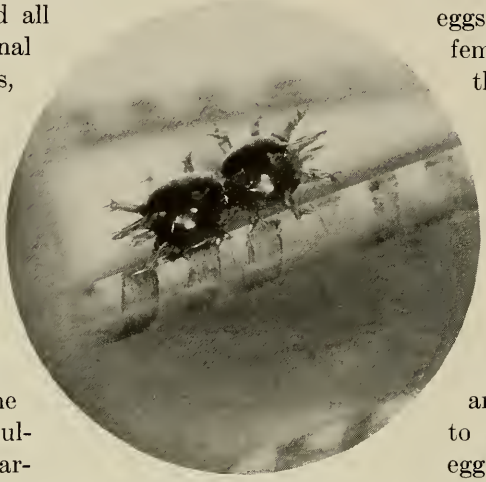
Notommata copeus extends earlike flaps from its head to use in swimming. They are fringed with moving hairs which draw the animal through the water

A PROTOZOAN COLONY OF BELL-ANIMALCULES (*VORTICELLA CAMPANULA*)

Each individual is anchored by a delicate thread of protoplasm which contracts spirally when the owner is disturbed. Highly magnified strands of pond scum (*Spirogyra*) are conspicuous, spiral chlorophyll structures showing through the transparent, tubular walls. Two strands are forming spores, being connected by ladder-like rungs in the process

plant cell of its endochrome. It then proceeds to the next cell to repeat the process.

After passing the mastax, the food reaches the large stomach, which is the most conspicuous organ in the rotifer's body. In the group, it is easy to see this organ and all the rest of the internal anatomy of each species, as the animals are clearly transparent. The stomach has a comparatively thick wall composed of a limited number of large cells which are clearly visible in the larger species and give the organ a somewhat mulberry-like appearance. Here, the food is digested, the residue passing out through the short and straight intestine. One urn-shaped species (*Asplanchnopus multiceps*) has a well-developed mouth and pharynx, as well as a large stomach, but there is no intestine present, the indigestible residue of the food being regurgitated through the mouth.



A MICROSCOPIC WATER PLANT
Xanthidium armatum is composed of two connected cells armed with spines, which enable it to cling to plant stems

All female rotifers have an ovary situated in front of the base of the stomach. When the eggs are developing, this organ may be so distended as practically to fill the body cavity. The eggs are laid in the water in most cases. Certain species, however, hatch them in the body cavity, the young remaining for a time within the mother's body. Males are very few, compared with the number of females, and are of much smaller size. They have a reproductive apparatus, but no mouth or stomach. They are therefore merely sexual machines which swim about for a few hours before perishing. During their brief career, some of them justify their existence by pairing with the females. The rest just die. The fertilized eggs last over the winter and hatch out the following spring to give rise to females. These produce unfertilized eggs which also hatch out females. Thus, during the summer, brood after brood of females are produced, until cold weather sets in during the fall, when male-producing eggs of smaller size are hatched out, making it possible for another sexual mating to give rise to winter eggs, as before.

Rotifers have a nerve ganglion, or "brain," in the head region, in close connection with which one or more red eyespots occur. A system of nerves connects the brain with various parts of the body. They also have paired "kidneys" and a simple muscular system. In short, they are remarkably complex creatures for their small size, and are in sharp contrast to the single-celled protozoa, associated with them in their microscopic environment, which, in some cases exceed them in size.

Thirty-one species of rotifers are shown in the group. This is not unusual in a normal prosperous community found within a cubic half-inch of pond-bottom, under the environmental circumstances represented in the Rotifer Group. A few of the more interesting species will be mentioned.

One of the largest of the rotifers may be seen crawling up a *Spirogyra* filament toward the left of the group. This is

A VISTA THROUGH A TANGLE OF POND SCUM (*SPIROGYRA*)

The spiral chlorophyll of *Spirogyra* is clearly visible. A large rotifer (*Notommata copeus*) is crawling up a strand, systematically perforating it, cell by cell, to pump out the chlorophyll for food. A utricle of the bladderwort is capturing a harlequin fly larva, which is struggling to escape. At the lower left an urn rotifer (*Asplanchnopus multiceps*) is seen, with its internal structure showing plainly through its transparent body

Notommata copeus. It has the habit of perforating the *Spirogyra* cells and pumping out the endochrome, like *Monommata longiseta*, mentioned above.

At about the center of the group, another *Notommata copeus* is seen swimming. It has a pair of "ear-lappets" extending on either side of its head. These are covered with moving cilia, the rhythmic vibrations of which propel the animal through the water. When it settles on a plant stem to feed, the lappets are drawn in. Just below it is a spherical colony of beautiful rotifers (*Conochilus hippocrepis*) consisting of about twenty-five individuals clinging together by their toes, while the combined motion of their wreaths of cilia causes the whole colony to rotate through the water. Close below the latter, a savage *Dicranophorus* is crouched with its toes resting against a branch of the bladderwort, in readiness to spring upon the next unwary creature that swims by. The utricle near it has apparently forestalled the *Dicranophorus*, for, through the bladder wall, a captured rotifer is dimly seen, vainly trying to find a way out.

Farther down the spray of the bladderwort, an insect larva (that of the harlequin fly, *Chironomus plumosus*) has just been caught by a utricle, and is struggling to escape. The more it struggles, the farther in it goes, for the utricle is lined with glandular hairs pointing inward. Thus, only the muscle contractions in an inward direction are effective. Soon the creature will slip wholly within, and will coil up like its fellow in the bladder farther up the stem, finally to be absorbed by this strange carnivorous plant. How is it possible for a utricle to induce a rotifer or other unsuspecting water animal to come and be caught? By looking at the utricle depicted on page 507, it will be seen that there is a trap door on the lower free corner of the bladder, from the edge of which project long, branched spines. Rotifers and other small creatures delight to browse among these spines, for small forms of life often adhere to them. In the course of their feeding, they may chance to come in contact with the trap-door. The shorter spines on the upper edge of the door hinder them from easily moving away, and meanwhile the slippery, glandular hairs which cover the surface of the trap cause the victim to slide toward the depression at the upper edge. Here the trap-door is very thin and flexible with a free edge gently held under a curving lip forming that part of the door-frame. As soon as the creature touches this flexible edge, it suddenly gives way and the unhappy explorer drops through the crevice, which immediately closes. The bladder does not digest the rotifer, for no digestive ferment is secreted, as in the case of terrestrial pitcher plants. The animal gradually dies, the fluid products of decay being absorbed by the cell-lining of the utricle, as food for the plant. Water-fleas and protozoa are also captured in this way.

Various species of protozoa are shown in the group. Down at the left, clinging to the base of the bladderwort stem, is a colony of beautiful bell-animalcules (*Vorticella campanula*). These are animals consisting of a single cell each. Superficially they remind one of rotifers, for the bell-shaped body is crowned by a circlet of cilia, but the internal organization is that of a protozoan, with a nucleus and contractile vacuoles. Each individual is anchored to the plant by means of a long, slender filament of protoplasm, containing a contractile thread of denser protoplasm. If the animal is touched or otherwise disturbed, the thread contracts, drawing the stem suddenly down to a close spiral, while the bell-shaped body and its ciliated disc contract into a ball. Soon the thread relaxes and the stem slowly lengthens, while the ciliated bell gradually expands and starts beating the water as merrily as ever.

A TUBE-BUILDING ROTIFER BUILDS ITS CHIMNEY-LIKE DWELLING

Floscularia ringens extends its pansy-like head from the top of its tube and models tiny, spherical bricks of brown mucus with the aid of the finger-shaped projection just back of its head. When finished, these are neatly cemented to the tube margin. The rotifer's home is thus built up like a tiny chimney of the most delicate masonry, resembling fine mosaic

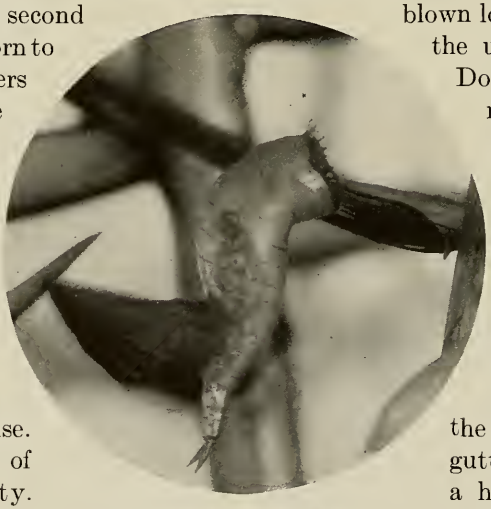
A little to the right of the center is a floating transparent ball, covered with hundreds of tiny green dots, enclosing a number of small dark green spheres. This is a protozoan colony (*Volvox*), often found in fresh water during the spring. The living colony is about half the size of a pin-head, and is very beautiful as it rotates slowly through the water. Each green dot is an individual protozoan, while the small green spheres within are developing *Volvox* embryos. Strange to say, a species of rotifer (*Ascomorpha volvocicola*) lives within the colony, and hatches its eggs there. The young grow and feed within the colony, possibly on the developing *Volvox* embryos, eventually making their escape, only to bore their way into other colonies of *Volvox*.

Perhaps the most beautiful of the rotifers are the flower-like stationary species. A good example is the tube-building rotifer, *Floscularia ringens*. The ciliary wreath of this fairy-like creature extends its petal-shaped lobes, causing it somewhat to resemble a pansy, around the rim of which the extremely delicate cilia vibrate in succession, like a transparent halo of motion. This animal builds a trumpet-shaped chimney to dwell in of tiny spherical bricks of brown mucus, secreted from glands of its body. It spins them into balls one at a time, by means of a hairy, spinning-projection upon its shoulder, and then, with a bob of its head, adds them to the upper rim of the chimney, which thus grows higher and higher. When the young are hatched, they make

their way out of the tube, and settle down on the outside of the parental mansion, to construct their own homes as additions to it. Soon, quite a branching cluster of these chimneys will be built up. Such a cluster may be seen on the edge of the dead leaf at the bottom of the group.

In the lower right-hand corner, near the branching chimneys of *Floscularia*, are magnificent clusters of two other stationary species. One of these, *Stephanoceros fimbriatus*, has built a double chimney of transparent gelatinous material, and shows one individual retired into its house, while the other extends its graceful head with five curving, fern-like arms out into the water. Fairy-like as this creature may appear, it is a most insatiable animal-trap, for its arms form a net to entangle swimming rotifers or protozoa. These settle down into a funnel-shaped vestibule from the bottom of which a hollow whip extends into a second chamber below. When the victims in the funnel touch the base of the whip, they are suddenly *snapped through its hollow lash* into the second room. Here they are torn to pieces by toothed pincers and conveyed to the stomach. So the fairy, after all, is a most voracious Gorgon!

In front of this creature, may be seen a colony of flower-like rotifers, living clustered in a roomy gelatinous house. This is a species of remarkable beauty. Its scientific name is *Octotrocha speciosa*. It was first discovered in China. Then some years ago, it was found in a pond on Long Island. Later on, Frank J. Myers discovered it abundantly in southern New Jersey, and within, the last few years, both Mr. Myers and the writer found it in ponds on Mount Desert Island. For the most part, it occurs in association with dead oak leaves but, in the latter locality, it was abundant on the water-plant, *Nitella*. How could such a species be of such sporadic and yet wide-spread occurrence? The most probable answer is doubtless the clue to the wide distribution of many rotifers. When pools, in which rotifers occur, dry up, the animals may die or, in case of many individuals, they may go into what is known as "resting stage." The rotifer telescopes into a contracted condition, and stops, with plugs of hardened mucus, any openings through which its small modicum of moisture might evaporate. In such a state, it will resist drying up. Yet, being of the size of a mote, it is easily caught by wind currents and blown long distances through the upper atmosphere. Doubtless, millions of rotifers, as well as their winter eggs, are sown all over the world by the winds, and, when dropped in favorable localities they dissolve out, come to life, and prosper once more. It is a fact that the dust from a dry rain gutter, on the eaves of a house, will be found prolific in bdelloid rotifers, when placed in a dish of water.



A TYPICAL ROTIFER

Cyrtonia tuba is a top-shaped creature crowned with a wheel-like wreath of cilia

Fruit Bats

FLYING SHADOWS OF THE NIGHT

An Account of a Few of the Two Thousand Species and Sub-species of Bats to be Found about the World. Blood-sucking Bats, Fruit-eating Bats, Insectivorous Bats, and Bats That Catch Fish

By G. G. GOODWIN
Assistant, Division of Zoology, American Museum

THE nocturnal habits of the bat and its peculiar appearance have caused it to be looked upon as a weird and uncanny beast. To the mind of the average intelligent person, bats are associated with witchcraft, evil spirits and ill omens; a creature set apart, neither bird nor animal, avoiding the daylight and making its appearance only at dusk, flitting about in the night with noiseless flight. Thousands of people only know the bat as an awful creature that gets into women's hair. Furthermore the wings of the bat have become the emblem of the infernal, and evil spirits are represented in painting with the wings of a bat, as opposed to the dove-like wings adorning the figures of angels.

While the bat has long been considered by the inmates of a house where it entered as a forboding of misery and death, it is looked upon by the Chinese as a most happy omen, and it was consecrated by the ancient Greek to Proserpine.

Bats are true warm-blooded animals, intensely interesting and possessing very few bad habits. They are the only animals that are capable of actual flight, and in this art they are past masters.

The flying squirrel and flying lemurs are not really entitled to the name. The membranous extension of the skin from the front to the hind feet merely serves to break the fall of the animal as it planes from the top of one tree to the foot of another. For speed, bats compare favorably with some of the fastest birds, and the perfectly controlled flight of the insectivorous bats far surpasses that of any of their feathered allies.

The bat family possesses a great diversity in form and size that is perfectly astounding. There are about 2000 different species and subspecies now recognized in the world, and they range all the way from little insectivorous bats not much larger than a humming bird to the great fox bats of the South Sea Islands, with a spread of 40 inches.

Some are beautiful, furry little creatures, others are fantastic, their faces fashioned like some complicated flower, and still

Photo by H. E. Anthony

PROTEST

Angry, squeaking protest at being wakened in bright sunlight

others are most hideous. Nature seems to have been at sport when she fashioned the heads and faces of some of the species, but it is probable that these queer facial expressions, long and peculiar ears, odd, curious noses, are not purely ornamental, and that their uses will in time be found out.

Blainville's flower-nosed bat stands out as one of the most fantastic forms. I took one of these curious little creatures in a cave on Mona Island. A native led the way to the bats about a hundred yards through a winding limestone cave. The bats were hanging from the roof in a small chamber where the air was stagnant and the heat intense. The specimen captured had large ears curiously curled, the chin decked with a highly convoluted bib of skin, and the eyes and nose almost lost in the folds and tubercles of skin that covered the muzzle.

Comparatively little is known about the life history of the bats, and their origin is hidden in the dim ages of the past. They must, however, be a very ancient family judging by the number of species that we have today. Fully developed fossil remains of bats have been found in the Eocene beds of Europe, hence we know that the first ancestors capable of flight must have lived many millions of years previous.

Bats are sociable and gregarious creatures, but as a rule both sexes do not intermingle, that is to say that in a colony of bats of a given species not a single individual of the female sex will be found, while in another colony not a single male will occur.

Systematists have divided the bats into two great groups, namely the fruit-eating bat, which comprises the largest species, and the insectivorous bat, which contains the greatest number of species, but by far the greater majority of the bats are serviceable to mankind in devouring vast quantities of insects. The only harmful species are some of the fruit bats which are found only in tropical countries, and destroy fruit, and a few that suck the blood of domestic animals. All of the bats found in the United States are both useful and harmless. And in any case their teeth are too small and weak to

Photo by J. P. Chapin

THE SLEEP DISTURBER

The males of this bat assemble in large flocks and call with resounding loud "pwŏkos" at half second intervals from sunset until midnight. For this purpose they have sub-dermal sacs covering the face and a huge ossified larynx that fills half their body cavity

more than puncture the skin of even a child.

The largest of the fruit bats, or flying foxes, are found in the tropical countries of the Old World. Under this category are included the smaller fruit bats of tropical America. The American fruit bats devour many kinds of soft pulpy fruit such as bananas, mangos, etc. At night in the West Indies I have seen trees in an orchard covered with a cloud of fruit bats screaming and fighting over the fruit. Occasionally I have seen them roosting in the daytime, clustered together at the top of a high tree, looking like a huge swarm of bees, but as a rule they prefer a dark or semidark cave in which to spend the day. At St. John's Island, American Virgin Islands, in 1925, I crawled through a small opening into a large dark cave where hundreds of fruit bats were hanging from the roof. It was too dark to see more than a swaying mass above my head, but the noise can only be described as like the rattling of numerous minature umbrellas. The moment I fired my gun all was confusion, it was as if the whole roof in one dark mass pitched downward and then came to life in a thousand whirling forms, churning past me in all directions, and the fluttering of their leathery wings as they billowed around my head was like the wind in the tree tops before a tropical storm. Though the air was so thick with bats that I could knock numbers down with one sweep of my hand, they never collided with one another, and with the exception of a slight touch here and there from the tips of their wings they did not molest me in the least.

Photo by Herbert Lang

PIG-HEADED

The wrinkled-nosed bat was first known to science because its swift flying seemed so impossible to follow that it was a challenge to a gunner

Photo by H. E. Anthony

"MY BACK, THEN"

The protest against the photographer's intrusion into the privacy of its sleeping quarters

All the bats found in the United States are of small or medium size, and they are all insectivorous. One of the commonest species is the beautiful little red bat which appears in the early evening gliding gracefully about up and down the shaded country roads. It can sometimes be found hanging close in amongst the leaves of an oak tree, and at the least sign of danger, it flits silently away to seek another hiding place. The hoary bat is one of the largest and handsomest species found in the Eastern States and is readily distinguished by its dark brown hair tipped with silvery white.

In temperate zones some bats like the red bat and the hoary bat migrate to a

warmer climate when the cold weather comes, but others, such as the common brown bat, may be said to hibernate.

Some bats may be considered carnivorous, like the Asiatic *Megaderma lyra* that is known to feed on frogs and smaller bats than itself. True vampire bats actually do suck the blood of living creatures. They appear to be most abundant in the valley of the Amazon, and where they are common, they do not confine their attacks to domestic animals alone, but will bite a sleeping man at night, usually upon the nose or feet. Fortunately their bite is not poisonous and apart from the loss of a little blood the victim suffers no ill effect.

Photo by Herbert Lang

SLUMBER

These bats hang head downward in times of rest, held by their claws securely hooked over a twig. When wrapped between the soft folds of their wings-little can be seen of the khaki-colored fur

Probably the most remarkable species of the whole bat family is the naked bat of Borneo. As its name implies, this bat is hairless, with the exception of a few stiff hairs on its neck. It has a gland or sac under the chin which secretes a substance with a very disagreeable odor. It is probably used like the scent-gland of the skunk, for self protection.

Records of a bat of the genus *Noctilio* catching and eating fish come to us from Trinidad, where it is asserted that this species lives in the caves upon the island of the straits, and comes out in the bright sunlight to prey upon the small fry or minnows which it catches by suddenly swooping down upon the surface of the water and scooping them up with its hind feet.

The story, however, is not new. Over half a century ago the legend was told by Kingsley in his entertaining book, *At Last: A Christmas in the West Indies*, but although he saw these bats at Mono Island making successive stoops at the water and actually striking the surface of the water, he failed to satisfy himself of the object of their manœuvers, and it was not until many years later that conclusive proof was obtained of the habits attributed to them by the natives of Trinidad.

Noctilio is among the very largest of the New World bats and is surpassed, or even equaled, by only one other species in the entire West Indian area. To give some idea of its appearance, it may be noted that the length from tip to tip is five and a half inches with a wing spread of sixteen inches. The general color is an orange tawny with a yellowish white stripe down the back. The head is large and rounded, with a bulldog-like face.

During a visit to Botany Bay, American Virgin Islands, in May, 1926, I had some interesting experiences with this bat, which was a frequent visitor at a small fresh-water pool at the side of the trail. This water hole was artificial, having been made by herdsmen to water their cattle during the prosperous years of the island. It was the only pool in a radius of about

three miles, and was about three feet deep in the middle and twenty feet in diameter. One side of it was lined with trees and thick bushes, the other was open to a low plain covered with a luxuriant growth of tropical vegetation teeming with insect life.

Visiting this pond on the evening of May 13 in search of frogs and salamanders, I was surprised to hear several successive loud splashes coming from the middle of the pool. Although it was quite dark I discovered that the disturbance was made by three large bats which were flying back and forth over the plain, and dashing down suddenly as they crossed the water. The night was too dark to see what species they were, but the musky odor in the air peculiar to the bat in question, identified them as *Noctilio*. Later, when the moon rose, some close-up views of these bats striking the water revealed that at this pond at least they were not fishing. Neither fish nor insect could be seen near the surface of the water before the bats struck, and specimens which were captured immediately afterwards did not have any trace of food in their mouths. The action was too rapid to see exactly what happened. The interfemoral membrane seemed to be stretched out to scoop up the water, and the head thrust forward either in search of food or to drink.

Noctilio were usually seen a little after sunset, flying two or three together about ten feet from the ground. They were easily distinguished from the fruit bats by their larger size, steadier flight, and mottled wings. The first arrivals in the

From "British Mammals." Courtesy Longmans Green & Co.

THE BAT IN FLIGHT AND AT REST

Thornburn, noted British artist, has successfully depicted a flying bat with tail membrane drawn under to catch the insects

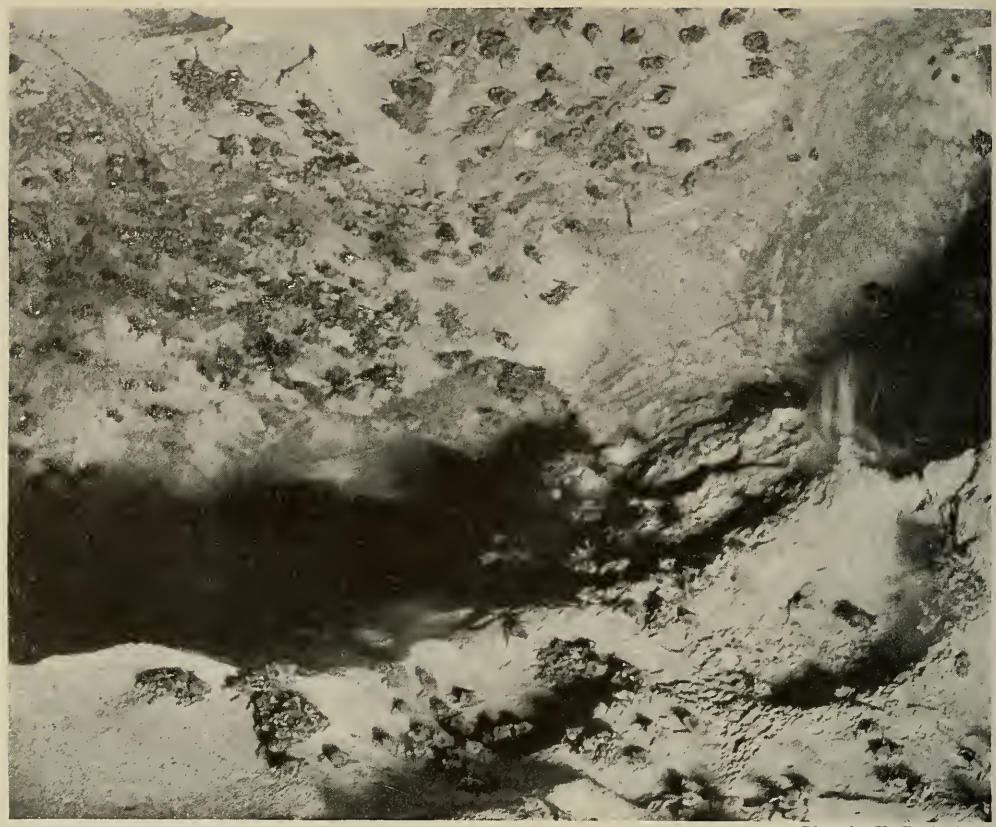


Photo by H. E. Anthony

SOCIAL AIRMEN

In cave-colonies the bats keep thickly congregated. Note the triangular mass on the upper left wall

evening flew at considerable speed as if coming from a distance, and reminded me more of swallows than of bats. They visited the water regularly at intervals of about twenty minutes. Upon arriving at the pond they made two or three successive splashes and appeared to be drinking rather than fishing. They always hit the surface of the pond near the middle where it was deep, whereas the fish, of which there were plenty, were always seen in shallow water near the sides. Sometimes as they passed me on the way to the pond they made a sharp crunching sound as if grinding the horny parts of a large beetle between their teeth.

An examination of the stomach contents of five specimens of *Noctilio* taken at Botany Bay, showed the remains of insects exclusively. One hundred per cent fish remains, however, showed in the analysis of the stomach contents of one specimen of *Noctilio* from Trinidad. The most noticeable evidence of these fish remains was the many minute particles of silvery white argenteum of fishes that glittered in the light. The stomach also contained recognizable fragments of fish scales, apparently of an anchovy.

The most extensive records of the fish-eating habits of *Noctilio* seem to come from specimens collected at Mono Island, near Trinidad. Charles Kingsley, writing of his observations of this bat at Mono Island, has the following paragraph: "As it grew dark, dark things came trooping over the sea, by two's and three's, then twenty at a time, all past us toward a

cave near by. Birds we fancied them at first, of the color and size of starlings; but they proved to be bats, and bats, too, which had the reputation of catching fish. So goes the tale believed by some who see them continually, and have a keen eye for nature who say that the bat sweeps the fish up on the top of the water with the scooplike membrane of the hind-legs and tail. For the last fact I will not vouch. But I am assured that fish scales were found, after I left the island, in the stomachs of these bats; and that of fact of the picking up of small fish, there can be no doubt."

Not long after this the story was revived by Dr. G. H. Kingsley, who visited Trinidad during the cruise of the Northumbria, and who, like his brother, watched the movements of the bats in question. Under the heading, "Change of Habits in Animals," he published an article in *The Field*, and states that, "On the opposite side of the strait, or Boca, is another cavern which is the roosting place of a colony of large bats, with teeth and wings perfectly fitted for insectivorous feeding. What do they do? Give up insect-hunting, and go a-fishing. They came out in the gloaming, and fluttered and splashed on

Drawing by F. B. Shields

FISH-EATING BATS

In Trinidad these bats deserted older insect-catching habits and take their prey of fish by swooping down and scooping up the small surface-living species

Photo by J. P. Chapin

THE HAMMER-HEADED BAT

Africa's largest bat, with a wing spread of 40 inches. Entirely frugivorous, this bat restricts its diet to the juices of the fruits it eats

the top of the water, and somehow or other caught tiny fish. I floated about many a hot evening to see how it was done; but, though I was close to them—close enough to be nauseated by their detestable scent—I could never quite make up my mind on the subject. On the whole, I was inclined to accept the native idea that they scoop them off the surface with the interfemoral membrane. However it was done, they certainly did catch fish and eat them; for I found fish-scales and bones in their stomachs, and had microscopical slides prepared to prove it."

In conclusion, it may be added that *Noctilio* is not the only bat that has been reported to catch fish. So long ago as 1863 Dr. Shortt reported having on two occasions witnessed the big fruit bat of India (*Pteropus*) perform the same feat.

Photo by Herbert Lang

ALL EARS

Unlike the other insect catching-bats, this species feeds like a flycatcher and not like a swallow. After each slow foray the bat returns to its tree to eat the insect that was captured

Photo by J. P. Chapin

LEAF-NOSED BAT

The peculiar skin configurations this bat bears upon its nose are coupled with acute sensory capacities. Blinded bats flying in a dark room can dodge silk threads suspended from the ceiling

Photograph by Martin Johnson

BIRDS OF AFRICA'S BIG GAME FIELDS

Feathered Residents in the Land of Lions and Zebras. The World's Largest and Some of the World's Most Interesting Birds

By JAMES P. CHAPIN

Associate Curator of Birds of the Eastern Hemisphere, American Museum

TELL your friends that you are sailing for Mombasa, and they will at once guess that you are off on a big game hunt. But all depends on one's tastes, and whatever these be, they are likely to find some satisfaction on the broad highlands of East Africa. For my part, much as I enjoyed visiting this hunter's paradise, it was certain that most of my time would be occupied with the birds. So possibly I need not describe the herds of hoofed game that we admired from the Kenya and Uganda Railway on that memorable morning when we awoke between Makindu and Simba, and looked off to the southward for the glistening snow-cap of Kilimanjaro.

We had already devoted a week in the vicinity of Mombasa to making the acquaintance of the birds of the coastal belt. During our first evening on the train, in the thirsty thorn-bush country beyond Voi, we continued our studies as best we could, by shining a focussing flash-light from the car window, seeking the reflected beam from the eyes of nocturnal birds or other creatures. And besides the paired optics of several small carnivores, the more ruddy gleams of goatsuckers' eyes rewarded us a half-dozen times within the space of an hour and a half.

The next morning we saw our first ostriches and kori bustards, the big game among Africa's birds. The ostrich is at once the largest and probably the most primitive of the living birds of our globe, while the kori bustard, more properly a game bird, will weigh up to 30 pounds. A jolting train, however, is not the best place from which to watch birds; and a still more vivid impression was made on my ornithological memory some days later, on our way to the lion country east of Lake Victoria. We awoke in a trader's shack on the dry floor of the Kidong Valley. Looking out at daybreak we found a group of stately marabou storks standing in the short grass, solemn undertakers in white vests, waiting to dispose of carrion from about the neighboring huts. There was at the time a considerable trade in zebra skins, and raw hides hung on the wire fence.

Photograph by Martin Johnson

CROWNED CRANES

These birds sometimes gather in flocks numbering over fifty. When they have gone to roost at sundown on high trees, they often give utterance to loud, mournful calls, which are accompanied by repeated gruntings

It was clear that they would have to dispute their meal with the crows and ravens that perched on the fence posts, but the marabous' gigantic beaks left little doubt as to the outcome. The attractions for other birds were less clear, but a flock of glossy starlings, cheeping and chattering, shimmered in the rising sun, their steel-green coats extending over the upper chest, but replaced by warm rufous lower down. Equally brilliant sunbirds began to flit about in a natural flower garden near by. Sparrows of unfamiliar color-pattern gathered on the low acacia bushes, while brown-backed Livingstone's chats hopped on the road, or showed a white patch above the tail as they flew to their favorite bush-top. Sweet whistles from the distance were contributed by the streaked brown larks, which in Africa are usually less bubbling with energy than the skylark of Europe.

My eyes could scarce wander off the birds, but my companions were scanning the open plains, dotted with ant-acacias, in search of larger game. In several directions were grazing herds of hartebeeste and gazelles, here and there a few ostriches, and finally a group of giraffes, To the northeast rose the old volcano of Longonot, to the south its fellow, Mt. Suswa. Scattered about were low hills of jagged lava, and our guide and counselor, Alfred Klein, recounted his adventures with lions discovered by watching from these same hills at the crack of dawn. Sage and Mathews were still enjoying the thrill of the occasion when the other side of the picture was thrust upon us rather brusquely. Up rolled a Ford truck bearing a prostrate form, a man looking far more dead than alive, who had been tossed by a wounded buffalo the day before. He was bound for the hospital in Nairobi.

So on we traveled to the southward,

where the tsetse fly has no terrors for our modern mechanical beasts of burden. The next day we made the acquaintance of the secretary bird, the noisy lesser bustard, guinea-fowl, spur-fowl, tick-birds, and a host of smaller species. But a motor car is only a little better than a railway train for observing birds, and I was happy when we pitched our camp beneath some spreading thorn trees in the Ikoma district of Tanganyika Territory. Even there I chafed at the amount of attention given to big game. Most men have little time for watching birds when the plains are full of wildebeeste, zebra, eland, and all the rest of Nature's live stock. They care naught to follow a honey-guide—never more numerous than here—when lions have been roaring at daybreak, or a bunch of graceful impalla is gazing at them from the open, orchard-like woodlands. It takes a dyed-in-the-wool bird-enthusiast to prefer sport with a covey of francolins to adding an elegant eland head to his trophies.

Let us banish the mammalian fauna, in so far as possible, and talk birds. Scarcely a step need be taken away from the tents to begin. For a camp must have meat, and before long a white-necked raven discovers this, perching in some neighboring tree, and joined sometimes by the smaller vultures. Several times a day a honey-guide, if not two, would put in appearance and try to lure us off; and at night we frequently heard the reiterated call of a little scops owl. Nocturnal birds in Africa have usually found me readily tempted, but I confess that just here the number of lions we saw by day and heard by night made me rather squeamish about roaming abroad at night, even with the flashlight that is such an aid in discovering the birds. As a result there is still no scops owl in the American Museum from the Ikoma district.

Photograph by Martin Johnson

THE WORLD'S LARGEST BIRD

Ostriches will feed and drink in close proximity to large mammals. The cock birds in their black and white dress are far more conspicuous than their gray-brown consorts

In many other places, some even where there were lions, I have had better luck or more courage. An occasional distant roar from a lion did not prevent the hunting of goatsuckers and scops owls in the northern Congo in the old days when we had no focussing flashlight, and sought them at twilight or under the full moon. Later on, when back in the Kidong Valley, we did find the courage to pursue the coveted goatsuckers, and they were by no means so numerous as I had expected.

Once after nightfall I happened upon a pair of secretary birds which had gone to roost in the top of a large thorn tree. They might have been mistaken for vultures save for their long tails, black-banded as seen from below. But these long-legged birds of prey are at their best by day. Even the ostrich is less stately than the secretary, with his martial bearing and deliberate, measured stride, as he stalks alertly over the short-grass plains, or comes to drink at some pool.

Despite his reputation as a snake-hunter—and no doubt some serpents are killed—the greater part of the secretary's fare, in the cases we studied, consisted of large grasshoppers and lizards of several kinds, with only an occasional rat. June in the Kidong Valley must mark the beginning of their breeding season, and we were fortunate enough to find three nests with the old birds sitting on their eggs. They build broad flattish structures of dry sticks and grass-tufts torn up by the roots, which are placed on the tops of small trees or dense clumps of high bushes. Wary in the extreme when on the ground, moving off with such speed that it is almost useless to run after them, the secretary birds behave very differently while incubating. Mathews and I found one nest with more than a score of weaver-birds' nests swinging from the boughs about it, and we walked around under the tree wondering whether or not it could belong to the common augur buzzard.

CAMP IN THE KIDONG VALLEY
In the background are Mt. Longonot (left), and the Kikuyu Escarpment (right)

THE SHORE OF LAKE NAIVASHA

The shallows of this lake are covered by millions of lily pads. Mt. Longonot appears again in the background

Not until I struck the tree a second time did the secretary take wing. Then what a prickly task it proved to climb to where I could see the two bluish-white eggs.

Sage also found a nest by seeing a secretary settle on the top of a thick thorn-tangle. It was most interesting to watch his bird return to the nest. Walking through the fine grass, with cautious glances all about, it approached the base of the bushes supporting its nest, then disappeared as it circled to the far side. This was apparently in order to take advantage of the wind, and a few buoyant strokes of the wings carried it up-wind to its aerie. Soon it settled down so low that only its red face and long middle tail-feathers remained visible. How I longed to stay in the district and watch the upbringing of little secretaries.

We were a bit early in the season for ostriches. They seemed to have a definite breeding period, and from April to June we saw none save adults. Males were seen displaying in April near Ikoma, prancing about the female with outspread wings, but I believe that the hens began to lay in the Kidong Valley only after the middle of June. About three months later, Mr. Rockwell tells me that a brood of half a dozen very young ostrich chicks went scurrying along the road ahead of their car, in this same vicinity. The hen remained close at hand, evidently much concerned. While we were there, the adult birds were generally seen in groups of from two to six, the sexes almost invariably mixed, often feeding near grazing herds of antelope or zebra. Like most of the large mammals, they seemed far more wary when approached on foot than when a motor car passed near them.

This Masai Country race of ostrich is said to agree with the North African

Photograph by A. J. Klein

VULTURES BANQUETING ON A ZEBRA

This picture, which was taken in the Ikoma district of Tanganyika Territory, is typical of the big game fields. Most of these birds are Rüppell's griffon vultures, but an eared vulture can be seen at the right

ostrich in the reddish color of the neck, exhibited by the male in the breeding season. This color in the skin is somewhat obscured by the downy whitish feathering of the neck; but at times, especially when old cocks went running by excitedly, their necks did look pink or even pale red. Silent during the middle of the day, the ostrich nevertheless produces at night or in the early morning a deep call which bears some resemblance to the distant roar of a lion. A newcomer might be deceived, but would soon be set aright by the blacks, who point out that the ostrich roars or "bromms" in groups of three syllables, the second or third syllable being longest. This triple call may be repeated several times, but does not die away gradually like the awesome voice of his majesty Simba.

The ostrich is famed for its propensity to swallow all manner of hard objects. The most laughable story I have heard in this connection deals with the surprise of an English officer, standing near an enclosure on an ostrich farm, when one of the birds leaned over the fence, plucked a rifle cartridge from a loop on his chest, and promptly swallowed it. As the muscular part of the ostrich stomach usually contains a few handfuls of rounded stones and bits of bone, he may have wondered whether this mill would explode the charge. The hard objects merely aid in grinding the food, which perhaps includes almost anything deemed nutritious, but consists mainly of herbage, grasses and their seed-tops, leaves and pods of small pea-like plants, and leaves and fruit of many others. These often fill the large stomach, which is bent so that the thick-walled pyloric section, with its stones,

lies below and rather in front of the larger portion into which the food is first received.

Ostriches or their near allies once ranged eastward through Asia to Mongolia, but today are restricted to Africa and the deserts of Syria and Arabia. In Africa they are wanting over vast areas of the continent which are too well wooded for their taste. None is ever seen within the limits of the Belgian Congo. Through this partial isolation the northern and southern races have become distinguishable, and there are in addition recognizable subspecies in the Somali Region and the plains of the Masai Country.

In like manner the distribution of vultures in Africa is determined by the nature of the vegetation. Grassy plains and arid regions harbor the greatest numbers of large hoofed animals, and these in turn become food for the vultures. While the forests are not lacking in large mammals, these would die and go to waste where the forest blanketed them from the keen vision of vultures. Old World vultures find their food by sight, not smell, whereas it seems possible that the American vultures follow their noses to considerable advantage. Thus in forested western Africa only one vulturine species, the black-and-white *Gypohierax*, is truly at home; and it is so little like a typical vulture as to be often regarded as a sort of fishing eagle. Keeping largely to the banks of rivers, it finds dead fish from time to time; but perhaps the greater part of its food, in many regions, consists of the fatty husks of palm-nuts.

On the plain of the Kidong there were six species of vultures, ranging in size from the slender-beaked *Necrosyrtes* and the white Pharaoh's chicken—the latter decidedly scarce—up to the great eared vulture with bare red head. Among those of intermediate size, the white-

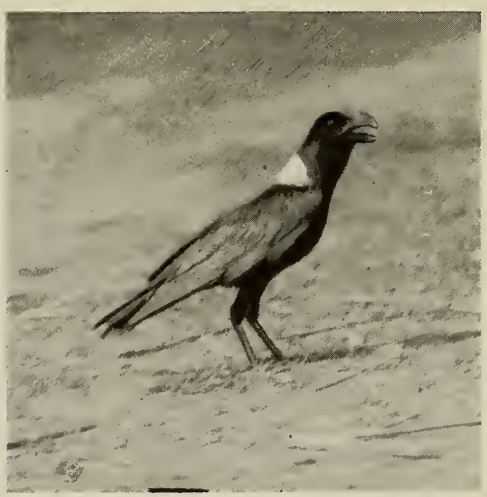
Photograph by E. R. Sanborn *Courtesy of the N. Y. Zoological Society*

A SECRETARY BIRD

It is said that the secretary bird received its name because of the long crest-feathers which, if one will but use his imagination, look like quill pens stuck over a clerk's ear

headed *Trigonoceps* is a striking bird in life, but most abundant were the two griffon vultures, *Gyps rüppellii* and *Pseudogyps africanus*. The griffons often feed together, and are not readily distinguished unless one sees the white patch on the back of the smaller *Pseudogyps*, only shown in flight. The huge eared vulture (*Torgos tracheliotus*) is almost always in the minority.

As the vultures struggle over a carcass, cutting through the eyes and thinnest parts of the skin, the marabous await their turn, and when loose bits of flesh are scattered about by the quarreling vultures, their long-legged companions stride into the busy mob and claim their share in the feast. The speed with which their combined efforts will dispose of a dead animal is astonishing. We met a trader who was collecting zebra hides, this being permitted at the time because of the extreme abundance of these animals. After shooting his zebra, he would have the first cuts for skinning made by a black helper. Then they went on after more zebras, and were followed in two or three hours' time by some black boys with an ox-cart. By that time the vultures had left only the skin and bones, and the crows were picking up the last shreds of flesh. A few cuts with a knife freed the hide from the skull and hoofs, and it was thrown on the cart.



THE WHITE-NECKED RAVEN
(*CORVULTUR ALBICOLLIS*)
This raven ranges from the native villages in the lowlands up to the most remote spots in the mountains, even close to the snow

Towards sundown the vultures would gather on the tops of trees, and then disappear. We found that many of them spent the night in the Njorowa gorge, a few miles to the northward, on shelves high up on the perpendicular cliffs. This gorge attracted us not only because it was frequented by many birds that found the vegetation on the plains too scanty, but because of the boiling springs that issued near the bases of the cliffs. On one of our visits, armed only with shotguns, we had an exciting moment. A sudden commotion in the scrub with violent shaking of small trees was our only warning. Out burst a cow rhino, followed by her calf, headed directly at me. At eight or ten yards she saw me, veered to her left, and then perceived Mathews in her path. Again both rhinos turned and disappeared in the bushes. During seven years of wandering in Africa, an infuriated wart-hog is the only creature that has ever given me a real charge.

There should have been kori bustards in the Kidong Valley; but we saw none there, and only a single Stanley bustard (*Neotis cafra*). The latter is more richly colored, with considerable rufous on the neck, and cock birds reach a weight of sixteen pounds. I suspect that the numbers of greater bustards, save in the game reserves, have been noticeably reduced by hunting. But the Kidong had a generous share of the small white-bellied bustards (*Eupodotis canicollis*) and they made their presence known by their loud mournful calls, especially in the

morning and late afternoon. As they find ready concealment in the grass, they are sometimes difficult to locate, and occasionally run off silently in the grass. Pairs are the rule, and the male seems to make most of the noise. Even an ornithologist may be forgiven for enjoying a meal of roast bustard. Fine birds they are, with dark red flesh even on the breast.

MARABOU STORK AND AFRICAN ROOKS
Together with the vultures, these birds profit from the activities of the lion and of carnivorous man

Now and then, especially at dawn and sundown, the raucous calls of francolins break through the chorus of lesser bird notes. These are partridge-like birds with spurs in the males, and in East Africa are commonly called "spur-fowl." In the Kidong the harshest "raack-k-k, raack-k-k, . . ." was the voice of the bare-throated *Pternistis leucoscepus*. More retiring, and skulking usually in the scrub along the edges of ravines and about lava bowlders, we found *Francolinus hildebrandti*. The male of this bird is heavily spotted with black below, on a whitish ground-color, whereas his consort is plain cinnamon-rufous there. When we recall that the hen of this francolin is exceptional in having spurs, it is not remarkable that the two sexes were long regarded as distinct species. The voice of *hildebrandti* is a confused chattering cackle. Out in the open grassy parts of the plain ran a smaller francolin (*F. hubbardi*) with the plumage on the sides of the head and throat bright cinnamon in the male. It, too, had a very distinctive call, consisting of shrill metallic notes, sometimes doubled, and repeated again and again.

Along with the francolins live the harlequin quail (*Coturnix delegorguei*), the button-quail (*Turnix sylvatica*), and in many places the helmeted guinea-fowl, whose voice is so like that of the domestic race. I have often had difficulty in persuading my companions that guinea-fowl were needed for the collection, and were not merely placed on earth to be plucked and dropped into the casserole. The fact is that guinea-fowl differ markedly with the region where they dwell; and while all the forms of *Numida* are little more than geographic races of a single species, there is a large number of such races. They differ mainly in the size and shape of the helmet or casque, colors of the bare face, color and shape of the wattles, presence or absence of "bristles" over the nose, and the coloration of the plumage of the neck and outer webs of the wing-feathers. Reichenow's guinea-fowl, which inhabits this southwestern part of Kenya Colony, is one of those with the longest and straightest helmet. The races with the least development of the casque dwell about the borders of the West African and Congo forests. Within the forests the helmeted guinea-fowl are wholly replaced by the blue-spotted species of the genus *Guttera*, with tufted heads.

The most strikingly colored of guinea-fowls, the vulturine, is not found in the Kidong Valley or adjacent highlands, but in the still drier areas from Somali-

land southward through the Taru Desert. Our first view of it was from the "brake van" of a freight train on the Kenya-Uganda Railway. A flock of perhaps twenty stood alert but motionless in the arid thorn-bush country, within thirty yards of the track, waiting for our long train to finish rumbling by. They make regular visits to water, and their presence will be known from the numerous tracks they leave in sandy spots. How they can run beneath the bushes! Try to follow them, and you find your clothes seized at every move by short, curved thorns.

Dry areas are likewise the favored haunts of sand-grouse. Their resemblance to grouse is superficial, and their strong flight betrays a nearer relationship to the pigeons. On the elevated plains of the Athi, the Masai Reserve, and the Ikoma district we occasionally flushed the large, dark-colored *Pterocles gutturalis* from patches of dry bare earth, while at Tsavo the daintily banded *Pterocles decoratus* came regularly in flocks at about 8:30 A.M. to drink at the river, or even where water overflowed from the tank for the railway engines. During the rest of the day they scattered far and wide, and were seldom seen.

Photograph by Carl E. Akeley

A FLOCK OF FLAMINGOS

Only a small fraction of the flock of which these birds were a part is shown in this view, which was taken on Lake Hannington. Perhaps nowhere else in Africa are these rose-colored birds to be found in such incredible numbers

One small bird well known to every hunter in East Africa is the red-billed tick-bird (*Buphagus erythrorhynchus*). Yet it may not be superfluous to mention some of its peculiarities. Finding its food on the bodies of ungulates, whether wild game or domestic livestock, it climbs about on their smooth hides more actively than a woodpecker on bark. The tips of its curved claws are needle-sharp, and like a woodpecker, it uses its tail as a prop. Now it explores the hair about the opening of an ear, or again hops nimbly sideways to dodge the swish of a tail. Ticks furnish almost the whole of its food, as may be verified from stomach-examinations; but they are supplemented by the animal's flesh and blood if it has a wound or sore. While often protected by law because of its ridding cattle of ticks, the bird may be a source of infection to the animals; and its services are not always appreciated either by native herders or white farmers. The dipping of cattle is a surer and safer means of destroying their ticks.

The tick-bird, like some of the noisy lapwings, is the bane of hunters. It mistrusts mankind, and often gives the alarm as it deserts its lunch-counter and flies off to a distant tree-top. Even where they are accompanying cows I have found them to be decidedly shy and difficult of approach after they have been forced to take wing.

Tick-birds are of two sorts; and whereas the red-billed is the usual kind in East Africa, the one seen in the grass-lands of the Congo is the so-called yellow-billed species (*B. africanus*). Its beak is thicker, and not entirely yellow,

THE SHORE OF LAKE ELMENTEITA
Showing flamingos standing in the water and flying in the distance, while in the foreground lie the bleaching bones of a hippopatamus

for the distal half is scarlet. Both are essentially similar in habits, and build their nests of dry grass and hair in hollows of trees or buildings. I once found a native boy who took a more romantic view of their home life. To set up housekeeping, he assured me, they sought out an old bull buffalo, and nested in the crevice beneath one of his broad horns.

How can I describe in a few words Nature's attempt to duplicate the humming birds in the Old World tropics? Admittedly the American hummers outclass the sunbirds of Africa in every respect: diminutive size, brilliancy of color, and skill in flight. Yet the sunbirds may take second place among bird jewels. Most of them feed at flowers, partly on nectar, but largely on small insects and spiders. They have long sharp bills, often gracefully curved, and extensile bifid tongues. Glittering metallic colors are largely monopolized by the males, which in a number of species have two lengthened tail-feathers.

Such long-tailed species are most numerous in the highlands of eastern Africa, and it is not easy to name the most admirable among them. The sickle-billed *Drepanorhynchus reichenowi*, common near Nairobi, has the wings and tail varied with rich yellow. It is often seen clinging to the stalks of the orange-flowered *Leonotis*, probing its deep corolla. Higher on the mountains lives *Nectarinia tacazze*, brilliantly glossed in the male with lilac and bronze, which finds its food partly in the foliage of trees, especially beneath the midribs of the aromatic leaves of *Hagenia*.

Early May, when we climbed to the glaciers of Mt. Kenia, is one of the rainiest periods of the year. After a couple of drizzling days in the mountain forest and bamboos, we emerged in the alpine moorland at about 10,000 feet. Then came patches of sugar-bushes (*Protea*) with gorgeous white flower-heads as big as chrysanthemums. Here for the first time we met *Nectarinia johnstoni*, a large blue-green sunbird with a red tuft beneath each wing. As we ascended farther, the sugar-bushes ceased, and at 13,600 feet the tall stalks of *Lobelia*

Photograph by A. J. Klein

ON PARADE

In many spots East Africa is a natural zoological park, where fences are needed in order to keep the specimens out—not in. Crowned cranes are among the many charming voluntary exhibits

appeared, clothed with blue-green flowers. These spikes now became the feeding place of Johnston's sunbirds, which we continued to admire up to 15,000 feet, where vegetation began to vanish. Here then was one of the largest forms of the tropical sunbird family, living only in the alpine zone, and flitting about in fog and fine drizzle on the misty heights just below the eternal snows. What a thrill it gave me later, on the Ruwenzori Range and the Kivu volcanoes, to renew my acquaintance with this hardy alpinist, who has found his way from peak to peak, over hundreds of miles of lowlands, until his colonies occupy the pinnacles of tropical Africa from Kilimanjaro and Kenia to the eastern Congo and northern Nyasaland.

Early in July we started from Nairobi on a motor journey to Uganda and the Congo. After crossing the Kikuyu highlands near Limuru the road descends to the floor of the Rift Valley, and follows it to the northward, passing three of the lakes that nestle in this depression. First we came to Naivasha, a fresh-water lake despite the lack of any visible outlet, about 6000 feet above the sea. Its shores are largely open except for thin groves of acacia trees, which grow especially near the streams emptying into the lake. Elsewhere patches of papyrus, the king of sedges, alternate with lower grassy vegetation; and the shallow water is covered with acre after acre of lily-pads graced with lavender-blue flowers, orange at the center.

On the level fields back from the muddy shores crowned cranes strutted in small groups, and flocks of Egyptian geese came there to feed. The spur-winged geese kept a little nearer to the margin of the lake, while the water's edge was the feeding place of sacred ibises, glossy ibises, white spoonbills, gray herons, egrets, spurred lapwings, ring-plovers, stilts, and jacanas. This last "book-name" is far less descriptive than the East African term, lily-trotter, applied to this peculiar maroon-colored shore-bird, with white throat and golden

gorget, because its long toes and straight thin nails enable it to cross the shallows on the floating vegetation.

Out on the water swam great numbers of dark gray coots, a few crested grebes, and more than a dozen great pelicans, pale salmon-pink in color. White though they seem as stuffed specimens in museums, the large African pelicans are truly pink in life.

Lake Naivasha is justly famous for its waterfowl. Dr. Van Someren has reported thirteen of the seventeen species of East African ducks and geese from this one body of water. Those that attracted our attention were spur-winged geese, on the shore; and out on the water the glossy-backed knob-goose (*Sarkidiornis*), the African pochard, dark in color but related to our red-head, the brown diving duck (*Thalassornis*) with a white spot on its back, African pin-tails, and most numerous of all, the yellow-billed ducks (*Anas undulata*). The last-mentioned are rather like female mallards, and as we neared the water, one of them flew off her downy nest packed with eight buffy eggs.

THE SUNBIRDS' LUNCHEON TABLES
Sugar-bushes in the alpine zone on Mt. Kenia

The picture would not be complete without mention of the flock of thirty or forty gray-headed gulls (*Larus cirrocephalus*), whose favorite station was a muddy bar on the outer fringe of the lily-pad area. This they would quit from time to time to come flying toward us, uttering hoarse "cacks" or a rasping "kra-a-a-h." Near them hovered a few whiskered terns, which seemed to breed there, as no doubt the gulls did too. Before we leave this spot, let me include a mite of a red-billed kingfisher with malachite crest, which was seen perching along the edge of the papyrus or shooting along low over the water, as it is indeed on almost every large river or lake which is not surrounded by forest.

Flamingos we failed to find here, though they have been reported; and I began to regret that I should probably not have time to go so far off our road as Lake Hannington, where they are known to dwell in myriads. The next day we were passing the southern end of Lake Elmenteita, and stopped to scan its winding outlines with our glasses. The road was perhaps a quarter of a mile from the shore and a few hundred feet higher. In many places the sandy beaches looked strangely peach-colored, but the nearer shore was screened by the delicate foliage of an acacia wood, and we did not realize what we were gazing upon till suddenly one of the patches fanned out in a sheet of rose-pink over the blue water. Flamingos!

Down to the shore we went, peering through the trees, and there came upon a flock of over a hundred flamingos standing on a broad muddy beach. The waters of Elmenteita are shallow and markedly salty. Few plants grow near the water, and the bird fauna is strikingly different from that of Naivasha. Near the flamingos, to be sure, drifted a flock of pochards and eight coots. A very few pelicans swam in the distance,

and some spurred lapwings and smaller plover ran on the shore. On the other hand, a score of avocets, with awl-like bills bent the wrong way, wandered about in groups of two or three. Their voice was a rather sharp "queek!"

We may be forgiven if we did not notice any other water birds. The lake was far too full of flamingos. The nearest flock saw us and edged into the lake until the water touched their breasts. For a long time they would not fly, or only scattered individuals took wing, soon settling again. Farther along the shore to our left were two more flocks, equally large. Sage busied himself with his motion-picture camera, and many of the birds continued to dip their heads and feed.

The majority of the birds were the lesser flamingo (*Phoeniconaias minor*) of Africa and Northwest India. I had scarcely expected to find the larger species (*Phoenicopterus antiquorum*) here at this season, as it ranges northward to the shores of the Mediterranean, and has been said not to nest in East Africa. Yet there were many of the larger kind, too, mingling in the same flocks, though outnumbered by the smaller ones in a ratio of 5 to 1. The larger species was readily distinguished by the lighter red coloring of its bill and the more uniform scarlet, rather than rosy, covering of its wings. From the flocks came a hoarse note intermediate between a quack and a honk, but it was impossible to decide whether this was the voice of only one or of both of the species.

Photograph by E. R. Sanborn

A VULTURINE GUINEA FOWL
A native of East Africa which was photographed in the New York Zoological Park

Looking at the bare ground beneath us, close to the water's edge, we saw a long row of flamingo nests, low platforms about seven inches across and only three or four inches high, built of mud scraped up from close about them. Rosy feathers lying on them were those of *Phoeniconaias*, but there were no eggs save one, old and addled, chalky white in color. Perhaps the breeding season was over; but we saw no young, though these have been found on Lake Nakuru in July, October, and November.

Traces of many other nests, much older, were discernible farther back from the water, built perhaps when the level of the lake was higher. Looking toward the far shore, we counted flock after flock lining the lake. From all that we saw here, and while following the road along the eastern side of the lake, we estimated the probable number of flamingos on Elmenteita at approximately 8000. This may be far too conservative, but I hesitate to go higher, as some of my readers will not be familiar with the likelihood of underestimating birds in flocks.

The flamingo in flight, with neck extended full length and long legs trailing straight behind, the wings beating in slow measure, is like no other bird now alive. The bird-lover as yet unacquainted with it has a thrill left to live for. Had we gone to Lake Hannington, I suppose, my story would have been far

more enthusiastic. Our experience might have been repeated, too, at Lake Nakuru, for as we passed there we noticed pink patches of flamingos scattered all about the shores, numbering perhaps from 5000 to 7000 individuals. But we climbed out of the Rift Valley again on its western side at Eldama Ravine, and made our way to the Uasin Gishu plateau.

We had left Nairobi in dry weather, and were surprised to find the roads across this next plateau deep with sticky mud, still flooded by rains. This difference in rainy seasons doubtless influences the dates of of molting of some of the birds. At Nairobi and on the Kikuyu highland, at the end of June, the dancing birds *Drepanoplectes jacksoni*) had already dropped their long tails and changed from black to brown. Near Eldama Ravine, across the Rift Valley and a little farther north, they were still in black nuptial dress in mid-July, dancing actively over the little circles which the males clip off short amid the grass. The apparent irregularities in the molting of such birds in East Africa may probably be explained by the doubling of the rainy and dry seasons so close to the equator, as well as by local differences in the duration of the rains. In any one locality the molting of birds which periodically change their dress may be expected to show the same regularity as the changes of season.

The panorama of Eastern Africa, as we crossed from the Indian Ocean to Lake Victoria, interested me not only for its own sake, but also as a contrast to the western half of the continent. Nearing Kitale, close to the base of Mount Elgon, we met for the first time the same species of sugar-bush (*Protea madiensis*) with which Lang and I had been familiar on the Congo-Sudan border, fourteen years before. As we traveled west from Kitale, with the misty heights of Elgon on our right, the wooded savanna took on the aspect of the northern Congo frontier, with a majority of the trees and bushes seemingly of identical species. Here, as farther west, it was a transition belt. We were fast approaching the area inhabited by plants and animals of tropical West Africa. One by one, old friends among the birds, the trees, and even the ants building their roadways across that of modern motor-driving man, made their appearance. It was some six miles west of Malakisi, almost on the political boundary between Kenya Colony and Uganda, that we came to the first small patch of elephant-grass, whose catkin-like spikes might well be chosen as the national flower of Uganda. This giant grass is widely distributed in western Africa, especially near the margins of the great forest. Faunal boundaries are necessarily gradual, but it was not many hours before we were plainly within Western Africa. True forests stretched across our road, and the birds of Uganda

A NIGHTJAR

This species is common in Uganda and the grasslands of the Congo, despite its scientific name—*natalensis*. The nightjars are relentless warriors against insects, and go into action every evening about six o'clock

include many West African species.

After a night at a comfortable rest-house—and here at last we secured two scops owls—we went on to Jinja, the thriving town at the outlet of Lake Victoria. For those who care for nothing more exciting, one might recommend the golf course overlooking Ripon Falls. Better yet, one may angle below the swirling waters where the fish pit their skill and courage against the nascent Nile, fighting endlessly to climb the falls. But for me there were still too many birds. Over the falls and over the golf links, at almost every hour of the day, flew parties of large white-throated cormorants on their way between the fishing grounds in the lake and their nesting colonies on the rocky islets amid the rapids. Other cormorants, including the smaller *Phalacrocorax africanus*, swam and dived in the swirling waters, or sat on rocks drying their outspread wings. Here they would be joined by their lankier relatives, the snake-birds, and by little white egrets. Hadadah ibises mourned vociferously as they flapped past, and marsh-terns beat their course more aimlessly and gracefully over the water, in company with small gray pratincoles, shore-birds that take their insect food on the wing. A brown marsh-harrier sailed in the offing; while on shore large shrikes, scarcely less bloodthirsty, perched in conspicuous spots. Slaty rails and rufous lily-trotters picked their way along the bank, and gleaming little sun-birds flitted through the bushes on the rocky dam over which the falls roared.

As darkness fell, goatsuckers appeared on the open fields, winging their erratic way low over the ground. Most of them were the dull-colored *Caprimulgus natalensis*, widespread in the grasslands throughout Central Africa; but my evening closed with a glimpse of a magnificent male pennant-wing (*Cosmetornis vexillarius*), with large white wing-patches and a long tapering feather flapping out from behind each wing. All but unknown in East Africa, this bird in numbers pays a yearly visit to Uganda and the northern Congo.

THE PENNANT-WINGED NIGHTJAR

As is the case with most of its relatives, including the whippoorwill of the United States, the night-jar is active only when daylight has failed, with the result that it can scarcely be photographed on the wing, but this inverted picture of an individual destined for the collection of the American Museum illustrates the male bird's, unusual form

THE LEAPING TARPON

One of the Most Spectacular of all Game Fish—A Master of Aërial Acrobatics, and a Prize Worth Any Angler's Efforts

By VAN CAMPEN HEILNER
Field Representative, American Museum

Photographs by Julian A. Dimock

THE tarpon (*Tarpon atlanticus*) has often been called the angler's delight. He is one of the world's best known and spectacular fishes. His stuffed skin adorns the walls of countless clubs and sportsman's retreats and his portrait in oils has graced the cover of many a magazine. Though few realize it, to him is due no small amount of credit for the development of Florida, yet he is by no means confined to that peninsula, the world's record having been taken in Mexico.

Largest of the herring tribe, the tarpon is more or less common from Long Island (summer) to Brazil. Occasional tarpon wander north along the Atlantic seaboard every summer and are frequently caught in nets; infrequently by anglers. At Hatteras, North Carolina, the fish seem to be more or less plentiful throughout all the warm months. While the writer has seen and caught very small tarpon up the rivers of the west coast of Florida, it is rather doubtful if they breed north of Cuba, or if so, rarely.

Tarpon are eagerly sought after wherever they occur. As a food fish they leave much to be desired, but as spectacular sport, when taken on the proper tackle, they have few equals. The majority of the tarpon clubs are in Florida, though there are some in Texas and Mexico, to say nothing of the famous club on the Atlantic side of the Panama Canal. Here, where the great Gatun Dam spans the Chagres River, is to be found some of the finest tarpon fishing extant. I am under the impression that an attempt was made at one time to tow a "live-car" full of tarpon from the Atlantic through the Canal into the Pacific but, so far as I know, nothing ever came of it. I see no reason why the tarpon should not flourish in the Pacific notably on the west coast of Central America. Other fish have been transplanted from the Atlantic to the Pacific with success, notably the striped bass (*Roccus lineatus*) from the Shrewsbury River, N. J., about 1870 to California, where it is now more abundant than on the Atlantic Coast.

The tarpon loves to frequent passes, channels, and cuts through the banks. Here he lies in wait for whatever small fishes the various tides will bring him.

A LEAPING TARPON OF BOCA GRANDE, FLORIDA
One can faintly trace the course of the line and can understand how the violent contortions of the fish are frequently successful in dislodging the hook

He can be caught either trolling or still fishing and the writer has taken young tarpon on salmon flies. In trolling, a baited hook or artificial bait is trolled slowly from a launch or skiff back and forth through the passes known to be used by the fish. In still fishing, a hook baited with crab or cut bait is lowered to the bottom and sufficient time given the tarpon to swallow the bait before setting the hook. The instant the fish feels the barb he rushes to the surface and hurls himself into the air in an amazing and sensational series of leaps in a frequently successful effort to free himself. So violent and furious are these jumps that the fish soon exhausts himself and, if he has not broken loose, can be soon brought to boat. There are, however, exceptions to this rule. One of the largest tarpon of which I know, taken by Mr. Schutt of the Long Key (Florida) Fishing Camp, jumped only once during the entire fight. At the end, as the fish was almost to boat, a large shark rushed up and bit it in two just behind the dorsal fin. The part remaining, which weighed over two hundred pounds is mounted and hangs in the Long Key Camp today.

In Florida, the best tarpon fishing occurs in May and June. Earlier in the season the fish are frequently caught along the viaducts of the oversea railroad, but at that time of year they seem to bite best at night. I have seen the tarpon around Cape Sable lying all over the flats and banks like shoals of bait, and I know of a harbor mouth in the Bahamas where at all times vast numbers of tarpon of thirty to fifty pounds weight may be seen through a water-glass lying on the bottom as thick as sardines in a can. "For ways that are dark and tricks that are vain" the tarpon is very peculiar. Sometimes where you expect to meet him, you don't, and vice versa.

I first became interested in the tarpon through the enthusiasm of my dear friend Mr. Anthony W. Dimock, father of Julian Dimock who took the photographs accompanying this article. No such photographs have ever been made since and probably never will be again. It was a happy combination of a great sportsman and a great photographer. Mr. Julian Dimock very kindly presented all his plates to the American Museum of Natural History where they portray for all time a pictorial history of this wonderful game fish.

My first tarpon weighed only twenty pounds but he might just as well have weighed two hundred so far as my sensations were concerned. The circumstances remain engraved upon my memory. A moonlight night, the ghostly arches of the viaduct, the put-put of the tiny launch that carried me crosswise to the rushing tide; then the strike, and the flash of silver, dripping diamonds of spray from its flanks, that catapulted itself into the air again and again, and yet again. A lot of water has flowed through those arches since that time and many have been the tarpon that have leaped at the end of my line, but that one can never be erased from my memory.

I remember one blazing hot day toward the end of March on the vast miles of banks off the southern tip of Florida. The tide had turned at about three in the afternoon and all along the great shoal from Sandy Key eastward to Snake Bight tarpon were leaping. The mullet were "in" and the water was discolored a milky white. As we slid across the flats in our little skiff propelled by an outboard motor we could see the long plumes of tarpon wavering for an instant on the surface. The sun set in a great ball of red fire as we started up a long blue-green channel that wound between the banks. I was fishing with an extra-light outfit

A FIGHTER OF CAPTIVA PASS, FLORIDA

This photograph shows the relatively, as well as actually, large gills of the tarpon. It is the gills that supply the oxygen that is necessary to the life of the fish, and the exceptional size of the gills in these fish makes possible their tremendous activity

A STRUGGLE ON A FLORIDA RIVER
When the fish feels the barb and hurls itself into the air, the angler needs all his quickness of thought and action in order to prevent the hook from being dislodged

A FIERCE FIGHTER ON AN INLET OF THE FLORIDA COAST
The violent struggles of the leaping tarpon, as recorded by the camera, show contortions of which one would not think the fish's body capable

A LEAPING TARPON AT MARCO, FLORIDA

This unusual picture shows clearly the graceful form and the powerful tail fin of the tarpon. At the lower left the line is also visible

ANOTHER TARPON TAKEN ON A FLORIDA RIVER

These leaping fish occasionally turn complete somersaults in the air. Evidently this occurred when the above picture was obtained

ANOTHER FIGHTER OF BOCA GRANDE
None of these photographs show the elongated hind ray of the back fin which is characteristic of this species, for it lies close to the back

made especially for me by James Heddon's Sons, the great Michigan rod makers, a rod that weighed only four and a half ounces and was more suitable for fresh water than for tarpon.

We came to the end of the channel and turned to retrace our wake. Suddenly there was a swift surge on my line and into the air bounded a tarpon. I could hear the tinkle of the spoon as he wrestled his head from side to side in an effort to dislodge it. But it held, and this seemed to increase his frenzy, for he was in and out of the water so fast that one wondered if I were fast to some great sea bird or a fish that preferred air to its natural element. The skiff drifted with the tide and the fish continued its mad leaping. Half the time I did not know whether I had him on or not. But then the line would straighten out and the dead weight would come at the end and I knew the fight was not yet finished. The tackle was so light that I could not easily force the fighting and it was over a half hour before I had him alongside.

He was nearly dead, worn out from his terrific exertions. We tipped the skiff down on one side and slid him over the edge. Back at the cruiser he weighed fifty-six pounds and today he hangs mounted on the walls of my studio, one of my proudest achievements with rod and line. For thrills aplenty try the Silver King on bait casting tackle!

I remember another day in late May on the West Coast. We were still-fishing in a pass. Tarpon had been rolling all around us some time previously but we could not get them to bite. I was drowsing in my seat at the stern of the skiff when I suddenly noticed the line, which I had stripped from my reel and laid on one of the thwarts, start to uncoil and slide over the edge into the sea. For several seconds I watched it as if fascinated; then when it had almost reached the end, I let it come taut and struck, once—twice. Almost immediately a tarpon shot skyward astern and a little to one side, and the battle was on. From then on the tarpon bit at anything and everything offered, and we landed seven.

So it goes. A friend, B. W. Crowninshield, landed over twenty-five tarpon between sunup and sundown at Boca Grande, a famous resort of these great fish. Tarpon as a rule run from thirty

to eighty pounds. Many are caught from one hundred and twenty to one hundred and seventy and these are large fish. Over two hundred pounds is exceptional. The world's record tarpon on rod and reel was taken by W. A. McLaren in the Panuco River, Mexico, and weighed two hundred and thirty-two pounds. We have a mounted tarpon in the American Museum, details of capture unknown, which from appearance must have run close to three hundred pounds. This I should think is about the limit.

Tarpon probably spawn somewhere in the Caribbean, possibly up fresh-water rivers from which they descend to the sea and wander all over. I have always felt that some must spawn up the fresh-water rivers of the west coast of Florida, for I have seen countless baby tarpon in them, but have never received actual proof of it.

There is no doubt that the majority of tarpon seen run from thirty to eighty pounds. Where the big ones are is a question. It occurs to the writer that as the tarpon grow older and larger they lose some of their agility and fall a more easy prey to sharks. Of course there are plenty of big tarpon still left, but the smaller ones outnumber them five and six to one, and the shark theory is at least plausible.

If you are one who loves angling, pack your tackle and make your plans next spring to slip down the coast to Florida or Texas or Panama or to the countless other places that fringe the Caribbean and try your mettle on one of the grandest of God's gifts to fishermen, that molten ball of flashing, gleaming silver, that master of aërial acrobatics, the leaping tarpon.

A PRIZE TAKEN NEAR FORT MYERS, FLORIDA
The tarpon, which is the largest of the herring tribe, sometimes reaches a weight of between two and three hundred pounds

LIFE IN MINIATURE

How Wax Models Are Made and How They Are Used in Museums to Portray Many Phases of Natural History

By EDWARD J. BURNS
Preparator, American Museum

Illustrated with Photographs of Models Constructed by the Author

THE museum visitor of today is invariably impressed by the life-like beauty of the flowers and plants reproduced in the various habitat groups, and marvels at the effective realism of the wax models showing the various forms of animal life. People frequently ask the question, "How long has wax-working been in use?" and many are surprised to learn that it is among the most ancient and widely practiced of the minor arts.

Down through the centuries of civilized art in every country we find it valued, often meeting with its use even among primitive peoples. The Maori of New Zealand model creditable medallions in wax, while there is good evidence that the ancient peoples of Central America and Peru were aware of its value and employed it extensively in the *cire perdue* process, an ingenious method of casting gold ornaments from wax models.

While beeswax itself is one of the more durable of organic substances when given ordinary care, as is attested by perfectly preserved specimens from the Fifteenth Century to be seen in many museums, it is indeed unfortunate that it cannot withstand being buried for as long a time as other materials; otherwise our collections of the art work of ancient peoples would no doubt be enriched by many beautiful objects rivaling their work in stone and metal.

Frequent references to the wax images of the gods occur in Egyptian and Persian records. In the days of Alexander the Great, the Greeks brought the use of beeswax in modeling and casting to such a high degree of perfection that the wax workers rivaled the sculptors in the life-like portraits they modeled and colored. Wax portrait masks of ancestors graced the atria of patrician homes during the Roman ascendancy. In this period it was also the custom to carry a wax effigy

of the recently departed at the head of the funeral procession—an exclusive privilege of the nobility and a custom of which remnants are to be found even today in religious ceremonies in Italy. In England an elaborately robed figure in colored waxes of Queen Elizabeth made at the time of her death, is one of the treasures of Westminster Abbey.

We read an interesting account in the autobiography of Benvenuto Cellini of his use of wax in casting the Medusa of his *Perseus*. Many miniatures in this material are known to have been made by this versatile genius and by most of the other prominent masters of his period. Michelangelo used it extensively in preparing models for his larger groups and also as the final medium for smaller works. A portrait medallion of Michelangelo by his friend Leone Leoni, still preserved in the British Museum, owes much of its rare beauty to the working qualities of wax.

During the periods following the Italian Renaissance the use of this material was not extensive until the time of Louis XIV and his immediate successors, when elaborately decorated wax miniatures were extremely popular.

For the past century the high excellence of the art has been maintained only by isolated artists specializing in medallions, notably the later English and French, who also have left us an interesting technique akin to cameo cutting. This process consisted of flowing a thin layer of light colored wax over a smooth, flat slab of the same material in a darker tone. Into this thin layer the figures desired were modeled in low relief, and the effect of transparent drapery was achieved by working down to the darker surface. The charming results obtained

A MANDAN WOMAN WITH A BULL-BOAT

This unusual boat is merely a round frame covered with buffalo hides. The Mandans, who lived near the Missouri River, used these boats on that stream and its tributaries, but obviously it does not compare in efficiency with the more graceful birch-bark canoes of other Indians

BLACKFOOT INDIAN WOMAN AND GIRL

This model group was constructed in order to show the uses of the travois, which was common among the Plains Indians before the coming of the white man. Prior to the introduction of the horse to North America by the Spaniards, the only beasts of burden known to the Plains Indians were their dogs, and small travois were made in order that the dogs might be loaded with small parcels. Once the horse became common, the travois was adapted to his size

by this method rival the excellent work done by the cameo cutters on Madagascar helmet shells, some fine examples of which are to be seen in the Morgan Gem Hall of the American Museum.

Numerous formulæ, some of which have unfortunately been lost, have been devised in the past to render the beeswax more opaque or translucent, harder or softer to meet the special requirements of the work to be done. A number of the waxes used by the early Italian workers were darker and more dense than those used at a later period, frequently approaching marble in hardness and fineness of texture. We learn that Vasari recommended "to render softer, a little animal fat and turpentine and black pitch are put into the wax, and of these ingredients it is the fat that makes it more supple, the turpentine adds tenacity and the pitch gives it a black color and consistency so that after it has been worked and left to stand it will become hard."

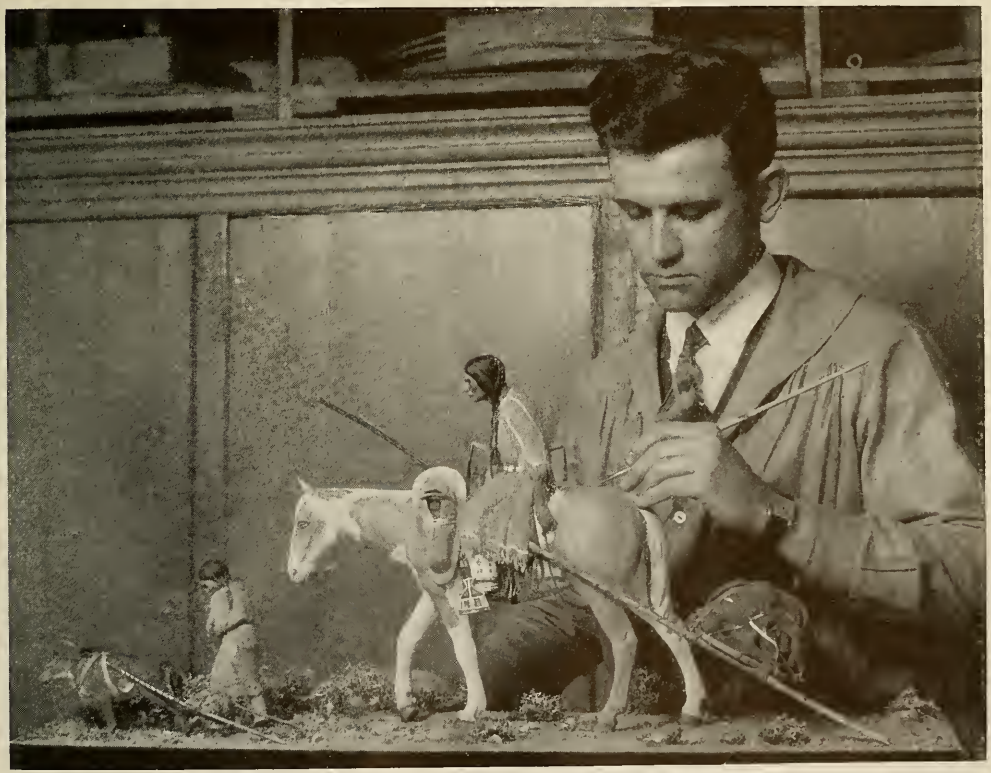
The development of exhibition work in the museum of today has increased the interest in the ready responsiveness of wax as a medium in producing lifelike exhibits of all living things. Its permanence as well as the facility with which its density may be controlled gives it first place in duplicating complicated form, colors, and textures.

Although some workers prefer to model directly in wax, it has been the writer's experience that better results are obtained when making miniature groups by first modeling the figure in plastelene, then making a plaster mould over it, and, after removing the plastelene, pouring in the melted wax which has pre-

viously been colored to the proper body tone. This preliminary modeling allows greater freedom in composing the figure and the subsequent casting gives a more durable and a cleaner surface than is obtained by laying on the wax bit by bit over the armature. The uneven texture and soot stains from the heated tools used in laying on the wax are thus avoided, and the development of the various delicate tones necessary to produce a lifelike effect is made possible.

A good example of the method of procedure in preparing a miniature may be found in the Blackfoot travois model recently added to the now complete synoptic exhibit in the Eastern Woodland Indian Hall, planned by the late Dr. Pliny E. Goddard to illustrate the various types of native culture in North America.

This group, which was designed to show the typical Plains Indian method of transportation, consists first of a Blackfoot woman astride a pony dragging a travois. From the pommel of the saddle a cradle board is suspended. Somewhat ahead of the pony a girl, carrying an armful of puppies, is walking beside a dog dragging a smaller travois. In making such a miniature group it is necessary, before starting the actual modeling, to study carefully all the literature available on the subject to be portrayed and to examine and measure the actual costumes, weapons, utensils, etc., wherever possible to insure the absolute accuracy of every detail, without which the



MR. BURNS COMPLETING THE TRAVOIS MODEL

Most of the models shown in these illustrations are made on a scale of two inches to the foot. Thus a man six feet tall would be reproduced in a model twelve inches high. The figures are all cast in wax, but many other materials are required for the accessories

STONEHENGE—RECONSTRUCTED

This type of model is particularly valuable in reconstructions of ancient ruins. Huge structures can sometimes be modeled in great detail but at comparatively small expense, as this ancient English ruin has been, and can be exhibited without utilizing much space. The original circle of stones is here reproduced on a scale of one quarter inch to one foot, and this model is now on display at the Children's Museum of Detroit

group would be of no scientific value.

The object being to tell a complete story of primitive transportation on the Plains, it was decided to include the dog travois in the same group with the horse in order to bring out the fact that both animals were used to drag loads. The dog was placed before the horse to call attention to the fact that dogs were used for this purpose before the horses were introduced into America by the Spaniards, and also to show that the larger framework pulled by the horse was evolved from the one designed for the dog. The woman riding and the baby on the cradle board carried suspended from the saddle help to complete the story of the methods of travel.

Before the modeling of the figures was started, measurements were made for all the objects to be used. The height and size of the woman were worked out from average measurements of this particular tribe. The average proportions of Indian dogs and ponies, just as important, were not so easily obtained. The dimensions of actual museum specimens of cradle board, saddle, bridle, quirt, and travois were determined and the whole brought down to the working scale of the group, two inches to a foot. The patterns of original costumes were also studied to assist in the proper draping of the figures, and attention was given to the methods of harnessing the travois poles to the animals. After all this data had been arranged, the modeling of the figures proceeded to completion, and after the wax casts were made, the various textures and colors of skin, hair, and leather were worked on. The beadwork designs were copied directly from actual specimens. The various parts of the group were then assembled. While the greater part of the model involved wax technique, for accurate reproduction some of the minor details required a variety of materials. So, just as the medallions of long ago were enhanced by actual small jewels and gold work, the silver ornaments on the woman's belt were cut from burnished aluminum, the saddle horn, cradle board, and stirrups

were carved in wood, and the harness and travois lashings were made from fine leather and rawhide.

The preceding details merely cover the main problems of construction. Numerous minor problems presented themselves, such as the selection of miniature travois poles. Most twigs appear too crooked when the bark is removed and taper too rapidly to duplicate the actual large poles of the travois. Numerous types of woods were examined and the upright shoots of maple-leaved viburnum were found to answer the purpose, for while a makeshift might have been used, the attention to small details of this kind helps to make the finished group more convincing.

Some interesting and often amusing side-lights on model making come up in the search for material suitable for the miniature reproduction of accessories. Often mere chance will produce the desired object. For example, miniature sagebrush was needed for several of the groups of the Plains Indians. It is doubtful whether sagebrush growing in clumps three inches high could ever be found, while the nature of the plant makes it difficult to model artificially. Having this need in mind, the writer while on a trip to Maine was quite fortunate in chancing upon a field covered with a low growth of reindeer lichen (*Cladonia*). Its resemblance to sagebrush was at once apparent and a quantity was brought back to the Museum where, after being treated with a preservative, it was arranged on artificial stems and colored from a sample of the real sagebrush with satisfactory results. On one occasion, the headdress of eagle feathers worn by a Sioux chief was reproduced by canary feathers bleached white and dyed brown at the tips; at another time the clothing of Eskimos was reproduced by using the fur of small rodents. The peculiar color and quality of the arctic fox was ob-

A TYPICAL HOPI PUEBLO

Due to the problem of size, this type of structure obviously can be completely shown in museums only by the use of photographs and models. In the foreground is shown the communal ovens, and the circular fence protects the entrance to the *kiva*, or underground club room, from which women and children are excluded

AN ESKIMO IN HIS KAYAK

This hunter is shown fully equipped for the pursuit of seals. Not only were the weapons tipped with ivory, which was commonly in use before the advent of the white man, but both ends of the kayak were also protected with strips of ivory to prevent damage

AN ESKIMO SNOW HOUSE

The winter dwelling common within the Arctic Circle. Among the natives of America the use of the arch was utterly unknown except as it was employed by the Eskimos in these snow houses

A BEAVER INDIAN ON THE TRAIL

This native of the Hudson Bay country is shown as he was shortly after the settlement of Canada by the whites. His toboggan is the original type from which has sprung the toboggan now so commonly used in sport

A SMITH SOUND ESKIMO WITH HIS DOGS

The Eskimos of the eastern portion of Arctic America harness their dogs as shown here. In Alaska and northwestern Canada the dogs are harnessed in tandem

KWAKIUTL INDIANS IN A DUGOUT CANOE

These Indians are typical of the Northwest American Coast region, and are remarkably adept at wood carving

tained by washing the skins of white mice repeatedly with weak dyes until the proper tone was reached.

Frequently the task of designing a model becomes more difficult when the people to be portrayed are extinct and few of their costumes and utensils are in existence. The Indians of Manhattan Island furnish a good example of this. Making a group illustrating their customs requires a careful study of the writings of the early Dutch settlers for information concerning them, and a checking up with the known facts regarding adjoining tribes still living who may have influenced the people in question. In fact, preparing an exhibit of our Indians may often involve some of the difficulties encountered in modeling a group of prehistoric man.

These new problems, which are continually coming up, afford one of the most fascinating aspects of model work, while the ever increasing need in our modern museums for concise and realistic exhibits portraying the history of man and his achievements, offers a limitless field for the future development of this ancient art which owes much of its charm to that wonderful gift of nature—beeswax.

A SIOUX INDIAN WARRIOR

In full ceremonial costume. The face was modeled from a life cast in the American Museum collections

NOTES

THE INTERNATIONAL CONGRESS OF AMERICANISTS

As announced in the previous issue of NATURAL HISTORY, the American Museum during the week of September 17 acts the part of principal host to an old and distinguished body of scientists, namely, the International Congress of Americanists. Since its organization in 1875, under quasi-governmental auspices, this Congress has held sessions—international relations permitting—every two years. During the present century, the sittings have alternated between Europe and the New World, and this is the third session in the United States and the second to be held at the American Museum. Henry Fairfield Osborn, president of the American Museum of Natural History and president of the American Association for the Advancement of Science, is chairman of the honorary committee of the XXIII Congress of Americanists.

The local Organizing Committee includes: Chairman, Franz Boas of Columbia University; Treasurer, George G. Heye of the Museum of the American Indian (Heye Foundation); and Secretary, the late Pliny Earl Goddard of the American Museum. Other members on the Committee are Stewart Culin of the Brooklyn Museum and A. V. Kidder of the Carnegie Institution, Washington, D.C. Since Doctor Goddard's death most of the organization work has fallen on the shoulders of Professor Boas, N. C. Nelson of the American Museum assisting in the capacity of Secretary pro tem.

The formal opening of the Congress takes place at 12 noon on Monday, September 17, with greetings by Mayor Walker, Honorary Chairman Osborn, and others. The first general session begins at 2:30 P.M. the same day and is followed at 8:30 by a reception by the President and Trustees of the American Museum of Natural History. The Tuesday sessions, both general and sectional, begin at 9:30 A.M. and 2:30 P.M. respectively, and the day's program closes at 8:30 P.M. with illustrated lectures on the Maya by Sylvanus G. Morley and Frans Blom. The Wednesday sessions are to be held at the Museum of the American Indian (Heye Foundation) and the American Geographical Society, 155th St. and Broadway, beginning at 9:30 A.M. On Thursday a forenoon session will be held at Columbia University, the afternoon being devoted to a boat excursion to Garrison-on-Hudson and a reception by President and Mrs. Henry Fairfield Osborn at their summer residence. The Friday sessions commence at 10 A.M. at the Brooklyn Museum and end with a lawn party at Glen Cove at 4 P.M. Saturday, September 22, sees the finish of the program at the American Museum of Natural History, with a general session at 9:30 A.M. and the closing session at 12 noon.

To date this XXIII Congress has a signed up membership of about 200, fully one half of which is from foreign countries. The papers submitted for the program number nearly 125, covering almost every phase of the problem presented by the aboriginal peoples of the American continent.

ASTRONOMY

THE FIRST FALL MEETING OF THE AMATEUR ASTRONOMERS ASSOCIATION will be held at 8:15 P.M. on WEDNESDAY EVENING, September 19, 1928, at the American Museum of Natural History.

A cordial invitation is extended to all the members of the Museum, as well as to all amateur and professional astronomers, to take advantage of the rare opportunity offered by this Association to participate in the study of astronomy by non-technical methods and to develop its cultural and inspirational value.

At this first meeting of the new season, it is hoped that those members who have carried on interesting astronomical observations during the summer will tell of their experiences and progress.

Special attention is called to the fact that the meeting nights have been changed to the FIRST AND THIRD WEDNESDAYS of each month.

Many prominent astronomers have already offered to address the meetings during the winter, and the Association is looking forward to full and varied programs, treating astronomy from every angle interesting to the amateur.

EXPEDITIONS

CENTRAL ASIATIC EXPEDITION.—The safe return to Peking of Doctor Andrews' entire party with a mass of palæontologic treasure after a five-thousand-mile expedition in Mongolia has brought rejoicing that he has again triumphed over the manifold obstacles of human and inanimate nature, and has brought his fifth Asiatic expedition to so successful a conclusion.

On August 16 Doctor Andrews cabled:

Expedition return. Well. Travels five thousand miles. Explores, maps much new country. Discovers new geological formations, fossil deposits. Finds residence sites Dune Dwellers, culture everywhere, yielding thousands stone implements, decorated bones, shells, tooth necklace, indicating that twenty thousand years ago Mongolia more densely populated than today. Have ninety cases fossils. Two skulls, many bones, skeleton of gigantic new mammal, possibly larger than Baluchitherium, humerus big as man's

body, new phylum. Huge Titanothere, extraordinary saddle-like skull. New Mastodon, spatulate jaw, lower incisors, eighteen inches wide. We consider extremely successful expedition. Unprecedented leakage gasoline forced early return.—ANDREWS.

The principal archæological discoveries for the season appear to have been made at Erhlien, a locality situated on the eastern border of the Gobi desert proper, not far from the Kalgan-Urga road. Ancient dried-up lakes mentioned at this place once furnished conditions suitable for the life of early man, similar to those found in 1925 to have formerly obtained at Shabarakh Usu and elsewhere on the western border of the Gobi. Fortunately, the finds this year, if not numerically richer than formerly, are more varied, yielding bone implements and ornaments as well as objects of stone, shell, and pottery. The culture is again that of the "Dune Dwellers," which now it will be possible to describe in much greater detail.

"*Ninety cases of fossils*" are magic words to palæontologists. The new mammal "possibly larger than *Baluchitherium*," with a humerus as big as a man's body, would be enough of reward for any ordinary expedition; but the huge titanothere wth extraordinary saddle-like skull piles Ossa on Pelion; and the new mastodon with the spatulate jaw will soon be adorning the monograph on the Proboscidea by Professor Osborn.

Of course we may think of the still bigger fossils that they might have found if the gasoline leak had not forced so early a return, but prudent folk will be glad that they cashed in on their luck when they did.

THE STOLL-MCCRACKEN SIBERIAN ARCTIC EXPEDITION is frequently heard from by wireless messages to the press. According to these reports, the "Morrissey" stopped at Chickagof Island where four Sitka deer were secured. From May 28 to June 20 they hunted on the Alaskan Peninsula for bear. Between forty and fifty bear were seen by the party, and nine of these were taken. A number of Grant's caribou were also added to the collections. Near Teller, Captain Bartlett was forced to beach the "Morrissey" to replace the propeller which had been lost. After hurried repairs they passed through Bering Strait, and headed westward through the Arctic Ocean to collect fish. At last reports the expedition was unable to reach Wrangle Island and was forced by ice to head south.

PREPARATIONS FOR A 1929 SIBERIAN EXPEDITION.—In order to make the necessary arrangements for an expedition into Siberia in 1929, Mr. William J. Morden, field associate in mammology of the American Museum, has recently sailed for Russia in order to confer with the officials and scientists at Moscow and Leningrad. It is Mr. Morden's plan to prepare this fall for the expedition next summer, when he hopes to collect specimens of the rare Siberian tiger (*Felis longipilis*), the saiga antelope (*Saiga tatarica*), the Altai wapiti or stag, *Ovis ammon* (the big horn sheep of southern Siberia), and other lesser animals. After his arrangements in Russia are completed, he will return to the United States in order to outfit for his 1929 expedition. Mr. Morden was the leader of the Morden-Clark Asiatic Expedition which, in 1926, crossed Asia from Kashmir to the Trans-Siberian Railroad and Peking. At that time his expedition collected *Ovis poli*, ibex, and other specimens, and was captured by Mongols while making an effort to cross the Gobi Desert. An article by Mr. Morden descriptive of his experience with *Ovis poli* is published in this number of NATURAL HISTORY Magazine.

THE TYLER DUIDA EXPEDITION sailed from New York for Para, Brazil, on July 21. From Para the party will travel up the Amazon by river steamer to Manaos on the Rio Negro. Smaller boats will take them farther into the north of the Amazon Basin to Mount Duida, across the Venezuelan border. Here they will spend several months in intensive collecting and making a reconnaissance, biological and geological, of the region. The members of the expedition are Mr. G. H. H. Tate, leader, Mr. Sydney Tyler, Jr., historian and photographer, whose generosity made the expedition possible, Mr. Raymond S. Deck, ornithologist, and Mr. Charles Hitchcock, geologist.

A RECENT LETTER FROM BARNUM BROWN, curator of fossil reptiles, tells of continued work at Folsom, New Mexico, by the joint expedition of the American Museum of Natural History and the Colorado Museum of Natural History. He says:

So far, nine arrows have been recovered, one complete, and during the excavation seven skeletons of the extinct bison *B. taylori* have been recovered. These include male and female skeletons. Two-thirds of the quarry, which is sixty feet square, have been exhausted, but it is probable that other artifacts will be encountered in the remaining portion of the quarry. These artifacts are of the finest workmanship in any stone culture so far discovered in America, and there is no doubt of their definite association and contemporaneity with an extinct species of bison.

EDUCATION

A NEW SERIES OF EDUCATIONAL FILMS AND TALKS for parents and their children has been prepared by the education department of the American Museum for Saturday afternoons dur-

ing the season of 1928–1929, beginning October 6 at 3:30 o'clock.

The lectures, illustrated with slides and motion pictures, present companion subjects to those offered in the School Children's Lectures, and correlate closely with the public school courses of study, but at the same time contain much of interest to adults as well as to children. The topics will include natural history, exploration, and American history.

Children's Fair, October 18–21.—To encourage agriculture, nature study, and conservation, the School Nature League is planning to bring together for public display in Education Hall at the American Museum a series of exhibits showing the garden and nature work of New York City children. Schools and organizations working with boys and girls from all boroughs of New York City, as well as any New York City resident 18 years of age or under, are invited to take part. The Fair has the combined and coordinated support and facilities of the American Institute, School Nature League, and the American Museum.

Exhibits will be judged on the basis of their educational value and prizes amounting to $2758 will be awarded. All communications should be addressed to Mrs. M. C. Coit, School Nature League, American Museum of Natural History.

The New Restaurant in the American Museum

After several months of planning and preparation, the American Museum on July 25 opened its new restaurant on the second floor of the main building.

Restful, attractive surroundings, quick service, and good food at cost for visitors and employees, have been especially sought by the Museum in establishing this model dining hall. It will accommodate one hundred people, and has been furnished with specially designed maple Windsor chairs and tables that combine comfort and beauty with necessary durability, while the woodwork is of old seasoned cherry, rubbed down with a natural finish.

The model restaurant recently opened on the second floor of the American Museum

In solving the problems of organizing a dining room that would be *en rapport* with the atmosphere of the Museum and its clientele, Miss Marion Jellicorse, the dietition-manager, not only drew upon her own wide and varied experience in designing tea rooms to fit particular needs, but she also procured the advice of leading hotel and restaurant men, members of the staff of *Good Housekeeping*, and managers of tea rooms of other museums, with the result that

the dining room has rapidly become a most attractive and popular rendezvous.

Societies and organizations affiliated with, visiting, or planning to hold meetings at the American Museum or in its vicinity are assured a cordial welcome.

THE LOUVAIN LIBRARY

At the inauguration of the Louvain Library, held July 4, Baron Ludvic Moncheur, Count Guillaume de Grunne, and Dr. Henri Schouteden represented the American Museum. During the ceremonies the representatives announced that the American Museum was presenting to the Louvain Library a complete set of the Museum's publications, including a bound set of the reports on the Museum's expedition to the Congo.

THE NEW HOME OF THE EXPLORERS' CLUB

Explorers are at last to have a club house in New York City in keeping with their importance. It will be a modest club house as such things go in the great city, but a thoroughly modern one, fireproof, commodious, and situated near the West Side museum groups, that is, between the American Museum of Natural History, and the American Geographical Society and the Museum of the American Indian, and close to the educational center at Columbia University. The site is at 544 Cathedral Parkway, on the south side of the street, about two hundred feet east of Broadway. It is on a plot fifty feet wide and seventy-one feet deep, and will rise eight stories in height.

The new club house will have a small lecture hall to accommodate three hundred persons. This is on the ground floor with lobby and coat rooms and lavatories so arranged that it may be used by those desiring a small meeting hall without interfering with the affairs of the club.

The second floor will house the James B. Ford library of exploration, a collection of great value to all students of natural history, geography, and the many activities allied with the work of the explorer. A librarian is in charge of this collection of books. On this floor is also located the large club lounge.

The third floor will contain the residents' lounge, card rooms, and some living rooms.

The fourth floor has already had space leased by The American Alpine Club, and has the regular club housing which is also carried up to the eighth floor.

The club house will have sixty rentable rooms, all sunny, all with running water, phone connections, and furnished in the best club style. Each floor will have a bank of showers, and a bath tub, these being in outside rooms as well. There will be no dark corners in the club house and it should be an ideal home for the bachelor, or the man temporarily residing in the city.

As for a time at least the club membership may not fill the entire house, surplus rooms will be leased to desirable tenants who are satisfactory to the renting committee.

One of the practical features about the new club house, a feature that explorers will appreciate, is the installation of large steel locker rooms for the stowage of equipment and other gear. These locker rooms will be available to the members. A breakfast room in the basement will afford breakfast and light lunches when desired by residents.

The new club house will be ready for occupancy on January 1, 1929.

BELGIAN TRIBUTE TO CARL AKELEY

Bronze Memorial Tablet for Carl Akeley's Tomb.—Permission to place a commemorative tablet of bronze on the tomb of the African explorer, Carl Akeley, who lies buried where he died in the heart of the Belgian Congo, has been requested by the Belgian Government in a communication received by the explorer's widow, Mrs. Mary L. Jobe Akeley.

M. Jaspar, Prime Minister of Belgium and Minister of the Colonies, has made the request through His Highness Prince Albert de Ligne, Belgian Ambassador to the United States. M. Jasper states that "this action is desired as a token of the admiration of the Belgian Government for the great American scientist" and that he wishes Mrs. Akeley to consider the offer as a kind tribute to the memory of her husband and to herself.

Carl Akeley died suddenly on November 17, 1926, on the high slopes of Mount Mikeno in the Parc National Albert of the Belgian Congo, where he and Mrs. Akeley had undertaken to fulfil a mission from Albert, King of the Belgians. Mrs. Akeley, aided by the other members of the party and her black boys, prepared Mr. Akeley's grave in the solid volcanic rock and, using the only materials available, built a coffin of native mahogany, metal-lined, and upholstered with woolen blankets. An eight-foot stockade of mahogany posts was erected around the burial plot to prevent the encroachments of the jungle. A great slab of concrete bears the explorer's name and the date of his death. The cement for this slab was carried by Mrs. Akeley's black boys from a government post a hundred miles distant.

The bronze tablet which the Belgian Govern-

ment now proposes to dedicate to Carl Akeley's memory, will surmount this cement slab. On a future expedition, Mrs. Akeley plans personally to supervise the placing of the tablet on her husband's grave.

HISTORY OF THE EARTH

Dr. Paul Woldstedt, one of the forty geologists of the Prussian Geological Survey, arrived in New York on Monday, August 13, to conduct during the next two and a half months extensive studies of the glacial deposits in the northern portion of the United States and the southern part of Canada. While here, he will be the guest of various specialists in different parts of the continent.

Following his visit to the United States Geological Survey at Washington, D. C., Doctor Woldstedt will call on Dr. Geo. H. Ashley, state geologist of Pennsylvania, to view the river terraces along the Susquehanna River and those along the Ohio and its tributaries near Pittsburg. Then he will pass to Ann Arbor, Michigan, where he will be the guest of Dr. Frank Leverett, glaciologist of the U. S. Geological Survey. From Ann Arbor he will go to Chicago University to be the guest of Prof. E. S. Bastin. Thence to the University of Wisconsin where Prof. F. T. Thwaites will show him the typical Wisconsin drift deposits. At the University of Minnesota, at Minneapolis, he will be the guest of Prof. S. W. Sardeson. At Iowa City he will call on Prof. G. F. Kay, state geologist, who will show him the varied glacial deposits of Iowa. Prof. R. C. Moore, state geologist of Kansas, and Dr. M. M. Leighton, state geologist of Illinois, will conduct Doctor Woldstedt over the glacial deposits in their respective states. In Canada Doctor Woldstedt will be the guest of Prof. A. P. Coleman of Queen's University, Toronto, and on returning to New York he will be the guest of Dr. Rudolph Ruedemann at Albany.

While in New York City on August 14 and 15, Dr. Chester A. Reeds, curator of geology in the American Museum, conducted Doctor Woldstedt over the ground covered by the glacial lake clays and the terminal moraine deposits in the Hackensack and Passaic basins in New Jersey and along the Hudson River to the Highlands of the Hudson at Bear Mountain. Doctor Woldstedt is making these glacial studies in America in connection with the revision of the glacial map of northern Germany.

EXTINCT ANIMALS

In a recent number of the German periodical *Aus der Heimat*, (41 Jahrgang, Heft 5), Doctor Berckhemer, of Stuttgart, describes the recent discovery of remains of a giant deer near Steinheim. The skull with its giant antlers was well preserved and, with part of the neck, was recovered from gravels of Pleistocene age in a sand-pit. This animal is closely similar to the great extinct Irish deer, a skeleton of which is mounted in the American Museum's Hall of the Age of Man.

Reviewing the various discoveries of giant deer in Germany, Doctor Berckhemer points out that there was a definite increase in the span of the antlers during the course of the Pleistocene Epoch. The earliest forms had an antler spread of little more than a yard, while in the most recent German specimens this span is more than six feet.

Dr. W. D. Matthew, professor of palæontology at the University of California, and former curator of the department of vertebrate palæontology in the American Museum of Natural History, returned to Berkeley August 1 after two months spent in the Museum. While in the Museum he worked on his forthcoming memoir of the Paleocene Mammalia of New Mexico. After many years devoted to these earliest known mammals of the Age of Mammals, his work is now nearing completion. He plans to return next summer to finish his studies.

NEW BOOKS

A Catalogue of the Mesozoic Mammalia in the Geological Department of the British Museum. By George Gaylord Simpson.

This very important work has just been published by the British Museum. Though the fossil mammals of the Tertiary period are fairly well known by hundreds of nearly perfect skeletons, the mammals of the Mesozoic Age, or the Age of Reptiles, are known only by a very few jaws and teeth and one or two other scraps. In these early times mammals probably played no more important part in the earth's economy than do moles and shrews today, and as a result their fossil remains are very rare.

Simpson has again gone over the whole field and reëxamined every known specimen with later appliances and a little more up-to-date knowledge, and has been able to throw a good deal of new light on these early forms.

Doctor Simpson was a student at Yale, where he studied palæontology under Professor Lull, who was himself a student of Professor Osborn's. This book on Mesozoic mammals is of such remarkable merit that Simpson is

to be congratulated on his achievement.

—R. Broom.

SCIENCE OF MAN

Dr. George Vaillant has just returned from a preliminary archæological survey of Middle America, supported by Mr. Clarence L. Hay. The outstanding result was the obtaining of a permit from the Mexican Government for excavations in the Valley of Mexico for next winter, political conditions permitting. At the invitation of the Carnegie Institution, Doctor Vaillant carried out a small excavation at their site of Uaxactun, Peten, Guatemala, that yielded important information on the early history of the Maya. He was enabled, through the courtesy of the Mexican Government, to bring back a small synoptic collection of the "Archaic" cultures of the Valley of Mexico. He also visited a number of sites on the highlands of Mexico and Guatemala, as well as in British Honduras and the Peten district of Guatemala.

PAST, PRESENT, AND FUTURE OF SCIENCE

Thomas A. Edison, as the greatest inventor of the age, was the central figure of the wonderful gathering of men of achievement at Mr. George Eastman's home on Monday, July 30, when the first demonstration was given of a new camera with which an amateur photographer can take moving pictures that will reproduce a subject in natural colors. Marvelously lifelike color pictures were taken of Edison, both seated with men like Mr. Eastman or Mr. Ochs of *The New York Times* beside him, or seated alone in a contemplative mood quietly enjoying the last puffs of a cigar. This long exposure of the face of the world's greatest inventor of all time is in itself of priceless value. Imagine a hundred years hence placing before an audience the portrayal of the lineaments facial characteristics of Thomas A. Edison! His pose when paired with President Osborn of the American Museum is interesting as a matter of contrast, for in trying to make Mr. Edison hear and understand, President Osborn's face presents every variety of expression and is full of movement and animation, while Mr. Edison is serenely contemplative and quietly thoughtful because he cannot hear a single word unless it is shouted into his best ear. A charming color picture is that of Mr. Ochs drawing Mr. Edison to him by the left shoulder and shouting into his right ear; this was one of the triumphs of the many Koda-colour achievements of the morning.

It appears that Mr. Edison recently visited the American Museum in his quiet way, and was especially impressed with the series of prehistoric halls explaining the ages of the past. Among the few but memorable words when he said "good-bye" to President Osborn on Monday evening were the following:

You are interested entirely in the past: you think in millions of years. Mr. Eastman here is entirely interested in the present: he thinks of all that is going on today. I am always thinking of the future and what future discovery may bring forth. Together we three represent all the phases of human thought.

NEW MEMBERS

Since the last issue of Natural History, the following persons have been elected members of the American Museum, making the total number 10,550.

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Master Archibald Young.

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For the enrichment of its collections, for the support of its explorations and scientific research, and for the maintenance of its publications, the American Museum of Natural History is dependent wholly upon membership fees and the generosity of friends. More than 10,500 members are now enrolled who are thus supporting the work of the Museum. The various classes of membership are:

[illegible]te Member (nonresident)*	annually	$3
Annual Member	annually	$10
Sustaining Member	annually	$25
Life Member		$200
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AUTUMN AND SPRING COURSES OF POPULAR LECTURES

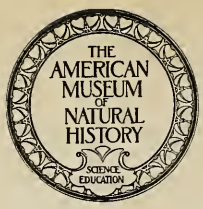
Series of illustrated lectures, held in the Auditorium of the Museum on alternate Thursday evenings in the fall and spring of the year, are open only to members and to those holding tickets given them by members.

Illustrated stories for the children of members are presented on alternate Saturday mornings in the fall and in the spring.

MEMBERS' CLUB ROOM AND GUIDE SERVICE

A room on the third floor of the Museum, equipped with every convenience for rest, reading, and correspondence, is set apart during Museum hours for the exclusive use of members. When visiting the Museum, members are also privileged to avail themselves of the services of an instructor for guidance.

SCIENCE
EDUCATION



RESEARCH
EXPLORATION

FIFTY-EIGHT years of public and scientific service have won for the American Museum of Natural History a position of recognized importance in the educational and scientific life of the nation and in the progress of civilization throughout the world. With every passing year the influence of the Museum widens, as is witnessed by the increasing number of visitors who daily enter its halls. Nearly two and a half million persons visited the Museum for study and recreation during 1927, an increase of 15 per cent over the preceding year, and all of these had access to the exhibition halls without the pay ment of any admission fee whatever.

The Museum's service to the schools has been greatly increased by the opening, last year, of the new School Service Building. Ten million contacts were made during 1927 with boys and girls in the public schools of New York and the vicinity alone. Inquiries from all over the United States, and even from many foreign countries are constantly coming to the School Service Department. Information is supplied to, and thousands of lantern slides are prepared at cost for distant educational institutions, and the American Museum, because of this and other phases of its work, can properly be considered not a local, but a national—even an international—institution. Through its loan collections, or "traveling museums," which are circulated locally, 495 schools were reached last year, and 1,722,433 pupils were directly reached. Nearly a million lantern slides were lent to the New York City schools, and 3,301 reels of the Museum's motion pictures were shown in 122 public schools and other educational institutions in Greater New York, reaching 1,123,704 children.

Lecture courses, some exclusively for members of the Museum and their children, and others for schools, colleges, and the general public, are delivered both at the Museum and at outside educational institutions.

For those interested in scientific research or study on natural history subjects, the Library, containing 115,000 volumes, is available, and for the accommodation of those who wish to use this storehouse of knowledge, an attractive reading room is provided.

Many publications, both popular and scientific, come from the Museum Press, which is housed within the Museum itself. In addition to NATURAL HISTORY, the journal of the Museum, the popular publications include many handbooks, which deal with subjects illustrated by the collections, and guide leaflets, which describe individual exhibits or series of exhibits that are of especial interest or importance. These are all available at purely nominal cost to anyone who cares for them.

The scientific publications of the Museum, based on its explorations and the study of its collections, comprise the *Memoirs*, devoted to monographs requiring large or fine illustrations and exhaustive treatment: the *Bulletin*, issued in octavo form since 1881, dealing with the scientific activities of the departments, aside from Anthropology; the *Anthropological Papers*, which record the work of the Department of Anthropology; and *Novitates*, which are devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters. The Librarian of the Museum, who may be addressed in care of the Museum, may be called upon for detailed lists of both the popular and the scientific publications with their prices.

Expeditions from the American Museum are constantly in the field, gathering information in many odd corners of the world. During 1927 thirty-three expeditions visited scores of different spots in North, South, and Central America, Asia, Africa, and Polynesia, and nearly as many are now in the field continuing last year's work or beginning new studies.

From these adventuring scientists, as well as from other members of the Museum staff and from observers and scientists connected with other institutions, NATURAL HISTORY MAGAZINE obtains the articles that it publishes. Thus it is able to present to the constantly enlarging membership of the American Museum the most fascinating and dramatic of the facts that are being added to the Museum's knowledge, or are deposited in this great institution.

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1928

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HAWTHORNE DANIEL
Editor

A. KATHERINE BERGER
Associate Editor

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A SMALL FIGURE OF BAKED CLAY FROM LIBERTAD, CHIAPAS, MEXICO
Each element is made separately and then joined to form a whole
(See "The Native Art of Middle America")

VOLUME XXVIII

NATURAL HISTORY

NUMBER SIX

NOVEMBER-DECEMBER, 1928

THE NATIVE ART OF MIDDLE AMERICA

The Development of American Art in Pre-Columbian Days—The Beauty and Virility of Maya and Aztec Sculpture and Design

By GEORGE C. VAILLANT

Assistant Curator of Mexican Archæology, American Museum

MIDDLE American art suggests to most of us mazy complications of form and line, further distorted by an elaborate symbolism. Rarely will a person admit the plastic and delineative arts of Middle America to a common ground of appreciation with the arts of Asia or Europe. This attitude of mind is caused largely by that complicated designs and by the grotesque divinities represented in this area. We forget the perfection of execution because of the difference between that æsthetic and ours. We fail to appreciate the fact that the ritualistic religion and the formalization of social life naturally are reflected in Middle American Art.

The customary introduction to the artistic forms of any nation is through examples that illustrate the point of view of its own æsthetic. In respect to Middle America, attention has been called to the sculpture of the Mexicans and Mayas, but the types and subjects are so foreign that they bewilder most people who have not a professional acquaintance with those civilizations. On the other hand, it is apparent, even to those who are not attracted by their first contact with the plastic forms of Middle America, that there is something far from primitive about these artistic manifestations. Yet the casual observer, in an excursion through a museum hall where such examples are on view, will let his general impression turn him away from a closer examination of individual specimens that, step by step, would lead him into an appreciation of the art of these people.

The purpose of the accompanying photographs, which were taken by Mr. Irving Dutcher and Mr. H. S. Rice of the photography department at the American Museum, with the aid of Mr. Edward Burns, of the preparation department, is to lead the reader up to the more complicated examples of Middle American Art, by showing specimens, mainly of sculpture, that are not burdensome by reason of detail and that relate to the human side of life. For the most part the examples selected have never before been illustrated, and are to be found on exhibition in the Mexican Hall of the American Museum.

HEAD OF TRACHYTE, COPAN, HONDURAS
(*Lowland Maya*)
This is a splendid specimen of Maya art. The nose of the figure has been restored

Right.—Design taken from pottery stamp, Valley of Mexico

PORTRAIT MASK, DISTRICT OF TUXPAN,
VERA CRUZ, MEXICO
(*Highland Nahua*)
Note the difference between the racial type represented by this mask and the head from Copan on the opposite page

Left.—Design taken from pottery stamp, Valley of Mexico

CLAY FIGURINE OF A WOMAN'S HEAD
From Azcapotzalco, Federal District, Mexico

conventionalization. But against this background, especially in the folk-arts, sometimes in the highly formal religious art, there are glimpses of a human element that is engagingly vital. It is by this folk-art that we shall try to bridge the apparent gap between the æsthetics of the Old World and the New.

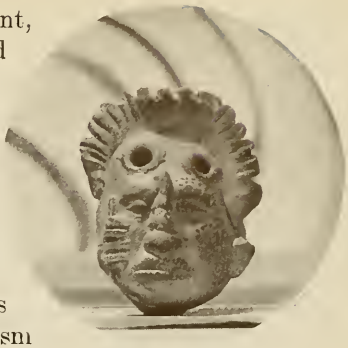
One of the principal phases of Middle American culture concerns the depiction of human beings. While it is doubtful if the specific portrait of any individual was ever attempted, there is a strong feeling for racial type, the inspiration for which may have come from the observation of fellow tribesmen. In the earliest cultures of which we have any knowledge in Mexico, the people attained considerable skill in modeling figurines in clay (shown on this page). Stone seems not to have been employed by these people. Certainly the manipulation of clay brings out subtleties of contour and depictions of detail that could not have been achieved in a harder medium. The number of methods employed in prep

Above—SEATED FIGURINE OF CLAY, TETELPAN
Federal District, Mexico

Below—HEAD OF FIGURINE, CONTRERAS
Federal District, Mexico. The heads on this page are representative of the earliest cultures found in the Valley of Mexico. Observe the attempts to reproduce expression and naturalism

The art of the peoples who inhabited the region between the Rio Grande in the north and the Isthmus of Panama in the south survives through their stone sculpture and pottery. Decay has removed from our knowledge almost all of the textile arts and carvings in wood. The residue shows us an art characterized by love of abstract form, by vitality, and by presentation within the boundaries of very definite rules. In the later and more civilized nations an extreme intellectualization obscures these basic principles. The elaborate system of government, largely by the priests, caused the artisans to construct temples with ornaments symbolic of elements of each nation's numerous gods, many of which were grotesquely represented. Ornament and the depiction of figures were reduced to an almost ritualistic

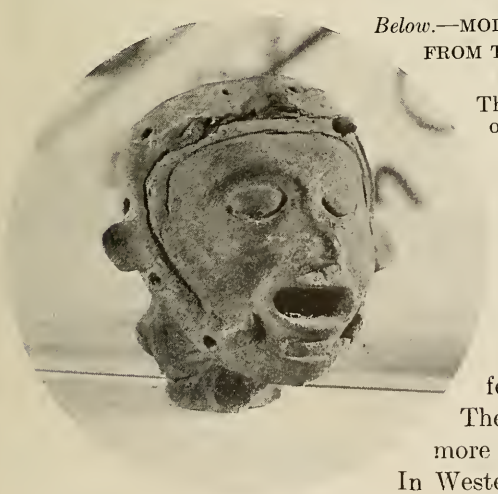
senting the features shows an art in fresh development, unbound by adherence to convention. Above idealized form is the attempt to instil life by depicting the true contours of the nose, mouth, and eyes. Since these people were probably like those of the present population, who are generally fleshy and long-bodied, the figures are presented as such, without the attention to bony structure so common among the ancient Greeks. Through the evidence of these "Archaic" figures, we see that the early tendencies of Middle American plastic were toward naturalism and vitality.



SMALL CLAY WHISTLE
Maya Culture
From the Usumacinta River, southern Mexico

Too little is known of Middle American archæology to treat of its arts chronologically, nor is it our purpose to do so, but rather to indicate some of their aspects. The art in clay always was important. From the time of the beginnings made by the "Archaic" people in Mexico, increasing mastery of technique developed such perfections of expression as the singing figure from Puebla or the whistle from the Usumacinta Valley, both on this page.

Above.—CLAY FIGURINE, MEDIUM SIZE
State of Jalisco, Mexico



Below.—MODEL MASK OF CLAY FROM THE VALLEY OF MEXICO
These specimens are of later date and of more finished workmanship than the preceding. Note the expression of despair on the figurine in the center

However, as is so often the case, clay remains a medium for the expression of the ideas of the common people. The laughing head from Vera Cruz (page 569) is really gay. The singing head from the same area, shown on page 568, might almost have been modeled from life. The bearded figure from Chiapas (page 562) was likened by a visitor to Rabelais' Panurge.

One might well ask why there are not more types of expression. Sentimentality is not a notable Indian characteristic. Neither is fear, nor among the ancient people of the New World is love or the idealization of feminine beauty emotionalized or stressed. The nobility of man and dignified silence, or, more rarely song and laughter, are expressed. In Western Mexico, the inhabitants modeled what

BOWL OF BLACK CLAY

Chupicuaro, State of Guanajuato, Mexico

The conception of true form is dominant in Middle America. Note the remarkable harmony in the proportions of this bowl. The vessel is burnished by rubbing with a stone or the end of a stick

POTTERY FIGURINE OF MEDIUM SIZE

Probably from southern Vera Cruz, Mexico. It apparently represents a person chanting. The modeling of the eyes and mouth is noteworthy

JAR OF LARGE SIZE

Buenos Aires, Costa Rica

The grace of proportions is matchless. The potter's wheel was unknown to the ancient inhabitants of the New World. The potter ordinarily worked by eye, building up the vessel in narrow ribbons of clay

"LAUGHING HEAD," FIGURINE OF CLAY

From southern Vera Cruz, Mexico. This gay little figurine is another successful study in human expression

must be frankly considered humorous figures. Their medium was clay. Human beings and animals, especially dogs, are treated lightly, almost as caricatures in some cases. The act is the preoccupation of the sculptor more often than the pose. To illustrate this characteristic we have grouped a pair of figures on the opposing page and the attempt to show action is obvious on the maker's part. A more dignfied pose distinguishes the woman making a tortilla (page 575), but pure burlesque is the man who must have partaken too freely the evening before (page 567).

Stone does not yield itself freely to whimsical expression, particularly when stone tools are used in the shaping. But its very intractability is an aid in depicting a serious subject. An extraordinary contrast in racial mien is apparent in a comparison between the trachyte head from Copan and the mask from Central Mexico. The dignity of the soft lowland Maya (page 564) one might construe as the majesty of position or of rank, while the highland Nahua represented by the mask (page 565) is noble, but from force of character. These sculptures epitomize the racial difference between the two stocks. The seated figure from Vera Cruz (page 574) blends the two strains. The modeling is simple and direct, but in the treatment of the surfaces something soft and tropical creeps in. This impression is increased when one looks at the uncompromising rigidity of the Nahua mask.

MONKEY DESIGN
Taken from a pottery stamp, from the Valley of Mexico

A characteristic of the sculpture of Vera Cruz and to some extent of all Middle America is the use of naturalistic elements worked into a scheme of pure design. The wild turkey in the example we give on page 572 is carved against a palmate background, the whole being more an effect of design than of sculpture in the round. This same combination of life-form with pure design is brought out by the stone disc carved in champ-levé (page 575), probably from the same area. Although the face is naturalistic, pure design elements are woven into so delicate a relation with it that the result is more a design than a presentation of life.

One of the most satisfactory mediums for the sculptor's art is wood, but owing to its quick decay it is rarely preserved. The mirror of polished obsidian (volcanic glass) shown on page 574 is surrounded by a wooden frame painted in gilt. The design is pleasing with its alternating squares of conventionalized flowers. Technically, however, the interest lies in the cutting and polishing of the obsidian of the actual mirror. The drum in the form of a tiger (page 573) is not only fine composition, but also exhibits a monumental quality, one of the striking characteristics of Middle American art.

Very often even the smallest objects have the capability of infinite expansion without detracting in any way from the harmony of their proportions. Also, large monuments may be diminished in the same way. Such a perfect relationship between the component parts of a figure as to permit its enlargement to monumental size occurs comparatively rarely. Other examples of monumentality are the effigy vessel from Vera Cruz which is reflected in the obsidian mirror and the Nahua mask of stone.

The conception of true form as exemplified by pottery manifests itself dominantly in Middle America. Almost in no other aspect of the arts does our

LARGE FIGURINES OF CLAY

The dog comes from the state of Colima, and the human figure is also from Western Mexico. Note how the vitality of each figure is brought out by placing the two together

classical training influence our appreciation and acceptance so deeply. But taking form and proportion as abstractions and not with relation to examples from a single national art, we find here harmonies of an entirely different sort. An excellent illustration of this feeling for pure form is the bowl from Chupicuaro, Mexico (page 568). The delicate convexity of the cylindrical vase from Salvador (page 573) removes from its shape the immobility of geometric form. Even according to Greek canons, what is more graceful than the high-shouldered pot from Costa Rica (page 569) built up by hand, and measured by eye, without the aid of a potter's wheel?

There is little left of Middle American painting. The decoration on the vessels from Salvador gives only a hint of the complicated drawing, of the extraordinary stylization that existed. Among the examples that have come down to us there is some good anatomical drawing, but generally the exigencies of religious representation remove the paintings from the common ground of artistic appreciation. A beautiful example of brush work exists in the decoration of a bowl of late Aztec period from near Mexico City. A marine worm, a water plant, and a fish appear simplified to their essentials, but none theless retain the lively characterization of species that one finds in Chinese drawing. (See design at top of page 576).

In the New World, from what evidence we have now, the textile art was well developed before pottery received serious consideration. Thus the designs for pottery were often taken directly from textiles. When natural forms are used in the arrangement of designs, there is a strong tendency to conventionalize and order them into the regularity of textile decoration. Space forbids our showing more than one example, from Jalisco,

STONE SCULPTURE

Above.—Probably from the southern half of Vera Cruz, Mexico. The naturalism of the wild turkey is preserved, while the element of pure design is fulfilled

Right.—The design is from a pot from Estanzuela, Jalisco, Mexico, probably textile in origin

WOODEN DRUM
Puebla, Mexico
Above.—One of the few existing specimens of the wood-carver's art in pre-Columbian Mexico

POTTERY VASE,
Nexapa, Salvador
Left.—This is decorated in polychrome. The draughtsman is hampered by the conventionalization of his style, and also of his subject, which is a feathered serpent emerging from a snail's shell

SEATED FEMALE FIGURE, IN STONE

Probably central Vera Cruz. The sculptor has avoided squatness and heaviness in his presentation of the figure

OBSIDIAN MIRROR WITH GILDED WOODEN FRAME

Presumably from Vera Cruz, Mexico. Reflected in it is an effigy vessel from near Tampico, Mexico

STONE DISC CARVED IN LOW RELIEF

Doubtless from southeastern Mexico. The cutting is exquisite, while a balance is struck between pure design and naturalism

LARGE POTTERY FIGURE OF WOMAN MAKING A TORTILLA

From Ixtlan, Nayarit, Mexico. Anatomical peculiarities are accentuated, but at the same time a realistic feeling is brought out by the vigor of the pose and the details of dress and ornament

DESIGN FROM THE INSIDE OF A BOWL OF THE AZTEC PERIOD, VALLEY OF MEXICO
A marine worm, water plants, and a fish are shown with a clear recognition of their species

Mexico. This is pictured on page 572. The applicability of these patterns to embroidery is an unexploited field and might open up more significant styles than the less purely textile decorations of the Peruvian ceramic.

Often stamps were used to print designs on cloth or even on the skin (pp. 564, 565, 570). The feeling is as textile as the painted patterns. Animate forms are reduced to their generic essentials. Pure design is handled in such a way that the elements have enough interest to overcome the monotony of repetition.

We have limited this discussion of some of the phases of Middle American Art to examples contained in the American Museum and to specimens that are associated with the life of the individual. A consideration of architecture, of the stelæ on which the Maya recorded time, and of the elaborate religious arts, would lead us far afield into a vast and complicated study of the religions, governments, national influences, and race of the Middle American peoples, in addition to the points suggested here. Art is always a reflection of its creator's perceptions and his habits of mind. Once one sympathizes with the controlling factors in the arts of the Middle American peoples, the coldness and the complexities fall away in the very perfect expression of the ideals and ideas of these little-known nations.

DESIGN FROM INSIDE OF A BOWL
Aztec period, Valley of Mexico
A representative treatment of balance and rhythm

THE APE-MAN OF JAVA

Does this Fossil Prove that a Creature Which Was in a Halfway Stage Between Man and Ape, Lived about a Million Years Ago?

By W. D. MATTHEW
Professor of Palæontology, University of California

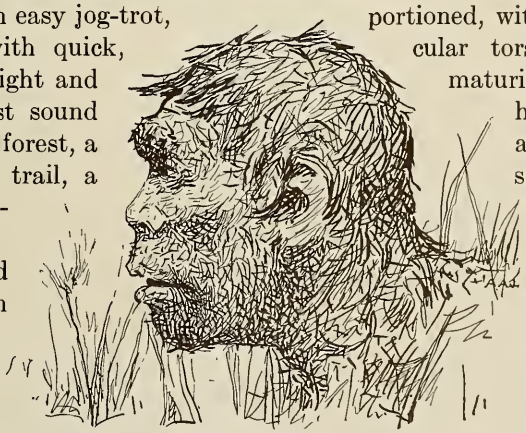
Illustrated by A. A. Jansson

In this article Doctor Matthew has written, first, an imaginary description of a group of Java ape-men in the setting to which it is supposed they were native. Then comes a discussion of the evidence on which the word picture is based. The setting is given in the following note.—The Editors.

SCENE:

A tropical forest, rather open, with huge, straight-boled trees scattered about. Some underbrush, but not enough just here to interfere with travel for either man or beast. A trail, half obscured by leaves and brush, that winds snakily across country, crossing or meeting with other trails and parting again, an endless labyrinth, familiar enough to the residents, quite hopeless to a stranger. For hundreds and hundreds of miles this labyrinth of forest trails extends to the north and west, mostly over broad, flat, swampy bottom, here and there with stretches of rugged hills and mountains where the dense and impassable jungle of the lowlands with its close-set trees and heavy underbrush thins out into open glades and scattered trees. Southward, if we should follow the trails a few day's journey, lies an irregular coast, rugged and rocky in places, heavily embayed elsewhere with swampy forests and a foreshore of gleaming sands all studded with swaying coconut palms. All along the coast, sometimes tied to the mainland, sometimes as separate islands offshore, lies a string of active volcanoes, steep, conical or irregular peaks, many of them emitting a trail of smoke to float off down wind.

THREE ape-men come trotting down one of the trails, tall, upright, broad-shouldered, their gleaming brown skin half concealed by sparse black hair. They run at an easy jog-trot, steady, watchful, with quick, flashing glances to right and left, noting the least sound or movement in the forest, a broken leaf by the trail, a displaced branch underfoot.



Every now and then they slow down to a walk or stop to examine some new or unusual object, track, or mark, crowding around it to see better, pointing and gesturing and expressing ideas in a sort of rude language of clicks and grunts. In their manner, their activity, and quick, changing interest, they are like a group of small boys, perhaps on their way to the swimming pool at the back of the woodlot. But they are tall, six feet in height, powerfully proportioned, with the heavy muscular torso and limbs of maturity, and the black hair over body, arms, and legs, while scanty for a beast, is too heavy to seem quite human.

The head is covered by a thick shock of tousled hair hanging over the sides and back of the neck. The prominent eyebrows form a heavy dark shelf shadowing the deep-set eyes, and the powerful projecting muzzle is nearly as big and heavy as in a gorilla. The set of the head on the shoulders, too, is

quite ape-like, and the retreating forehead, heavy black-whiskered jowls, and fierce and bestial expression are quite in contrast with the quick, restless, boyish activity of the running figures seen from a distance.

These are no harmless children—they are the rulers of the forest, savage, dangerous, and destructive, justly feared by all the animals of the jungle because of their uncanny cleverness and activity, and detested because of their restless, mischievous curiosity. Fortunate, perhaps, for the rest of the forest-dwellers that these ape-men are mainly vegetarian in their diet and have not the killer instincts of the weasel family!

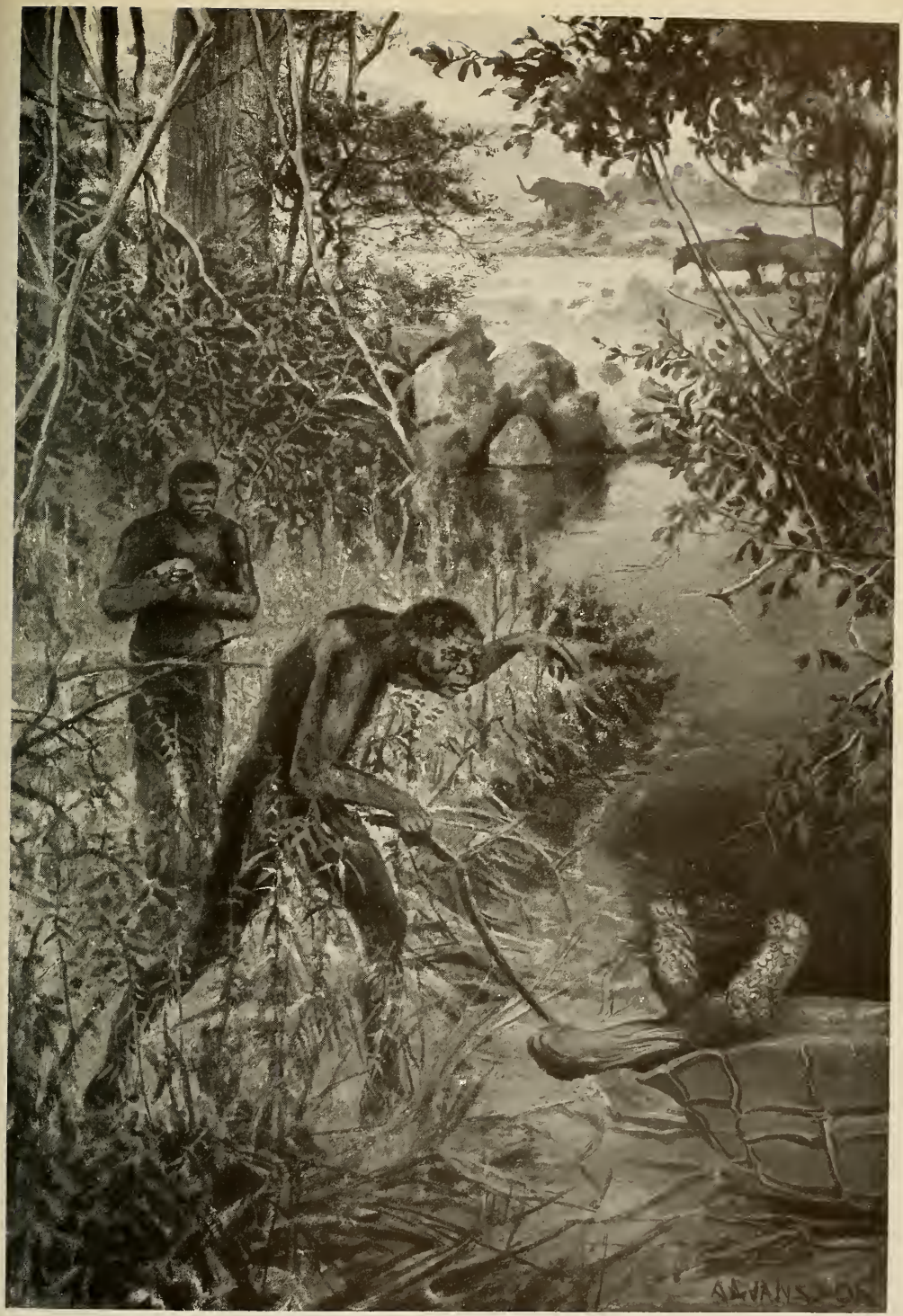
Even as it is, none of the jungle beasts, not the lordly elephant or the sulky rhinoceros, not even the tiger or the leopard, is safe from their mischief and deviltries. For, like the little monkeys in the tree-tops, they refuse to abide by the first law of the jungle—mind your own business—and the meddling curiosity that was but a slightly annoying propensity in the monkey has ripened in the ape-men into a spirit of investigation and experiment that affords infinite interest and amusement to themselves, along with a considerable spice of danger from some of the exasperated objects of their attentions.

Like the gang of boys which they suggested at a distance, our ape-men are really bound for a swimming-hole. It lies across the trail a short distance ahead, a broad, deep pool in a small river that in this dry season is a mere trickle above and below the pool. Here converge several trails, for it is a favorite drinking-place, and many of the larger animals for miles around find their way here during the day or night. Most of these are animals much like those that come to drink at a similar pool today—deer and cattle and forest-dwelling antelopes, elephants and rhinoceroses, and various large and small carnivora, porcupines and squirrels and other rodents. With these are some beasts now extinct, or unknown in this part of Asia.

A couple of hippopotami have made their home in the pool, and it is sometimes haunted by crocodiles, so that it is well to splash about a good deal and throw stones and sticks at any suspicious-looking objects in the water before venturing into its depths.

On the far side, driven off by the disturbance, a couple of gigantic tapirs retreat into the forest. They are much like the modern Malayan tapir, but as large as a dray-horse. A curious animal goes off with them, a chalicothere, with long neck and small, horselike head, the body of a tapir, and legs long in front and short behind, the feet bearing large claws instead of hoofs. He shuffles off with a curiously clumsy gait, carrying the claws sidewise as he goes, a shy, defenseless animal, hiding like the tapirs in the thickest depths of the jungle.

The next thing that draws the attention of our ape-men is a huge tortoise slowly and ponderously climbing up the steep bank. The massive shell, thick, heavy legs and neck, with small, blunt head, are like the modern giant tortoises of some oceanic islands. But he is enormously larger, the shell seven feet long and the rest all in proportion. As the ape-men come near him, he snaps futilely at their nimble figures, and then draws in head and legs and stubby tail under the protection of his massive shell. A perfect protection, this, against the teeth or prying claws of his carnivorous enemies, and his huge weight of nearly two tons is too great to be rolled over easily. This, however, is what the ape-men next try to do, and, by taking advantage of the slope and their united strength, they topple him over the bank to the sandy margin of the pool, where he lies upside down and helpless, waving head and legs about in a vain effort to get back on his feet again, snap-



TEASING THE GIANT TORTOISE

Like a gang of bad little boys, the ape-men topple the huge reptile over the bank to the sandy margin of the pool, where he lies helpless and snapping furiously at the sticks with which his tormentors prod him

ping furiously at the sticks with which they proceed to poke at any soft corners of his anatomy that they can reach. Soon tiring of this sport, they seek for more active game.

A movement and rustle in a leafy covert brings a shower of heavy and well-directed stones, which serves to dislodge a tiger lurking there. He springs for a moment into the open, then slinks off, bruised and battered, well aware that he stands but little chance of coming to close quarters with these active wily enemies, who at last resort could always scramble up a tree just out of reach and thence continue the attack with sticks and branches. The tiger driven off, the ape-men amuse themselves by pestering some of the smaller animals, routing out some of them from their holes or sheltered corners around the roots of trees, and exchanging missiles and abuse with a troop of monkeys in the tree-tops.

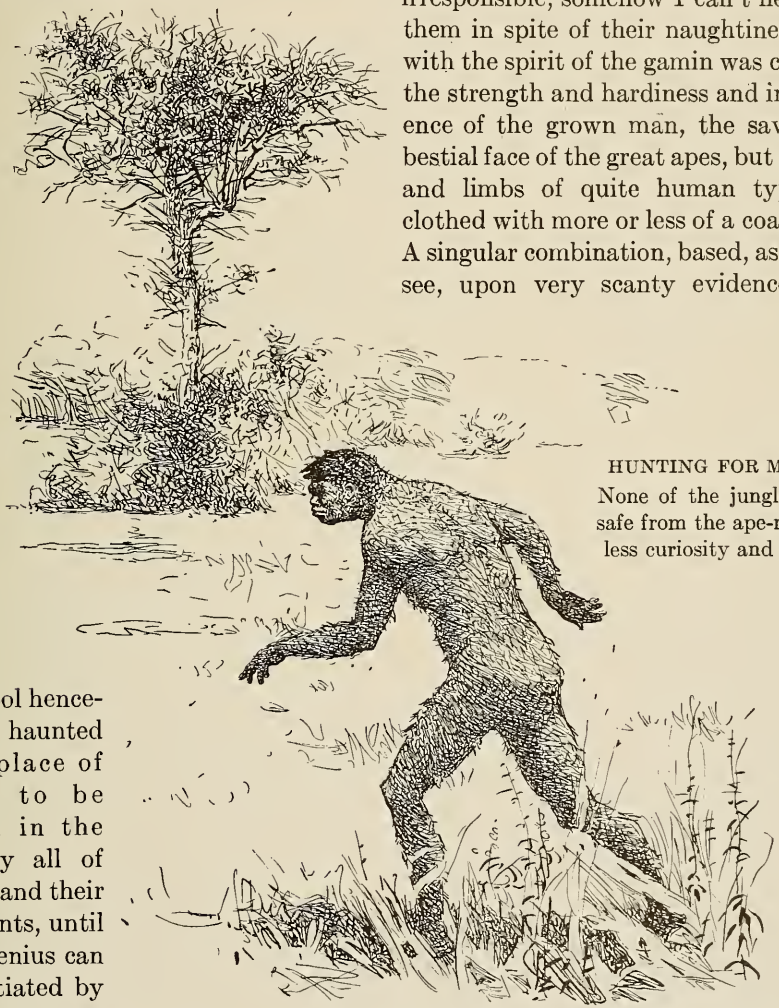
Pretty soon a rhinoceros comes down the trail toward the pool, and the ape-men begin throwing stones and sticks at him, irritating his natural sulkiness into a blind fury of rage, tempting him into useless charges, and dodging his clumsy rushes behind trees or rocks until he goes off battered, half blinded, and senseless with fury, his original purpose of a drink quite forgotten, chasing an imaginary ape-man whose original has long since dodged away from his path.

The next comers are a small group of elephants, a big bull in the lead, followed by two or three females and two young calves. They are not quite the modern elephant, although they look enough like it externally. The teeth, could one examine them, are short-crowned, with cross-crests instead of the vertical plates of the modern species. The bull has good-sized tusks, the females and young have none; the shape of head and proportions of body and legs are much as in the Indian elephant. This is the *Stegodon*, which was common throughout Asia in the days of the ape-man. Another species of proboscidean with which our *Pithecanthropus* was acquainted was the short-faced mastodon, smaller in size, with shorter legs and trunk, a low forehead, and teeth still less like those of the elephant, having only a few low irregular cross-crests instead of the serried ridges of the *Stegodon* or the vertical plates of mammoths and elephants. But we cannot meet the whole fauna of Pleistocene Java on this particular bathing excursion.

The *Stegodons* have a good memory, a keen sense of smell, and some very annoying recollections of ape-men. They promptly scent our heroes and, forgetting all about the water-hole, proceed to a vigorous and angry search for them, ineffective, because the ape-men are well aware that an elephant is a dangerous adversary, clever and with a long reach, and they keep well out of the way of the big beasts, but devote themselves to pelting the unfortunate little calves with heavy stones at every opportunity, until, bruised and terrified, the young elephants rush off down the trail and vanish in the distance, followed by their mothers, and after a little, by the bull, still angry but hopeless of any effective vengeance on his tormentors.

Now, the coast being clear for a while, the ape-men make for the pool to take a bath and cool off a bit after their somewhat heated interviews with rhinoceros and *Stegodons*. They splash into the water, ignoring the poor tortoise still lying on his back, but ever watchful for possible enemies in or out of the water. One of them, a little more daring than the others, plunges into the deeper water in the center of the pool and swims over toward the other side. Too far, alas, for with a sudden swirl of water a crocodile darts out from under the far bank, seizes the unhappy ape-man by the leg before he can get out of reach, and drags him

down to be drowned and devoured at leisure. His companions, very thoroughly frightened for once, splash back to the bank and up the trail at top speed, the last choking scream of their companion ringing in their ears, back to the lair which serves as headquarters or base-camp for the little tribe of ape-men.

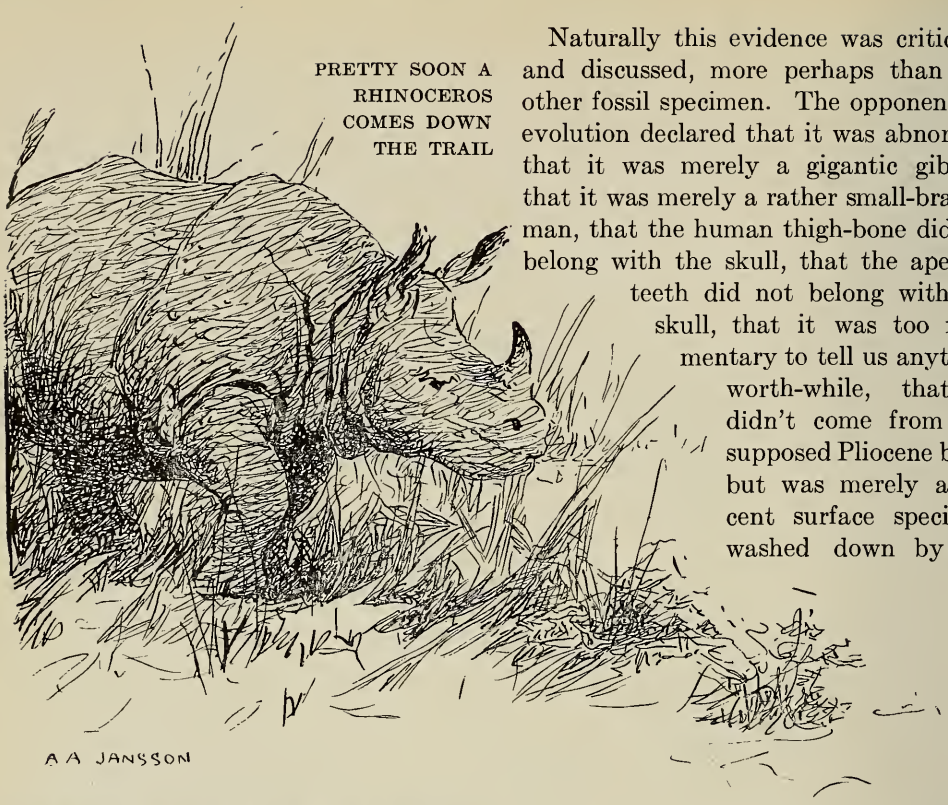


HUNTING FOR MISCHIEF
None of the jungle beasts is safe from the ape-men's restless curiosity and deviltries

The pool henceforth is a haunted spot, a place of horror, to be avoided in the future by all of the tribe and their descendants, until its evil genius can be propitiated by gifts from the wise old patriarch of the clan.

Of the unfortunate victim left to be devoured, only a few broken bones remain, washed down by the next flood and buried in the sand of the river, to remain there through the geologic changes and upheavals of a million years, and finally to reappear, a bit of rare historic record of the existence of a long-vanished race in a changed and civilized world.

Does this rude sketch sound like the escapades of a gang of bad little boys? I hope so. Because that is just what the ape-men were, as I think of them. Clever and restless, mischievous, inconsequent, irresponsible, somehow I can't help liking them in spite of their naughtiness. And with the spirit of the gamin was combined the strength and hardiness and independence of the grown man, the savage and bestial face of the great apes, but the body and limbs of quite human type, only clothed with more or less of a coat of hair. A singular combination, based, as we shall see, upon very scanty evidence, yet I think on the whole the most probable concept that we can build up from such facts as are to be had. Some day, when Java or other regions of central and southern Asia have been more extensively explored for fossils, we shall know how near this picture is to fact.



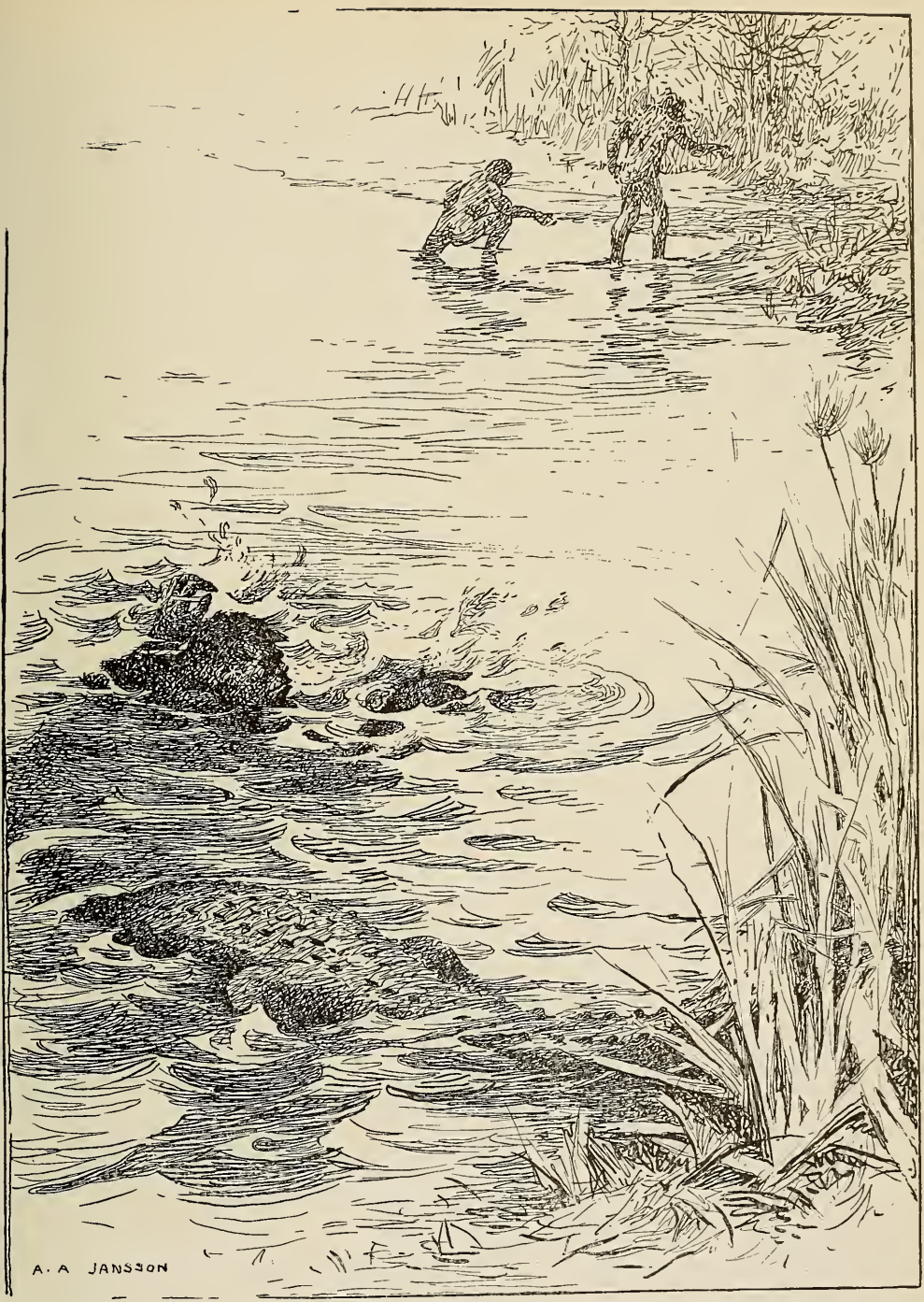
THE EVIDENCE UPON WHICH THE FOREGOING WORD PICTURE IS PRODUCED

Thirty-seven years ago Dr. E. Dubois discovered a fossil skull-cap, a couple of teeth and a thigh-bone, which he called *Pithecanthropus erectus* and described as intermediate between man and the anthropoid apes. These remains were found at Trinil on the Solo River in central Java, all in one stratum but the teeth two or three feet away from the skull, and the thigh-bone forty feet away.

The formation was at that time considered to be of Pliocene age. The skull-cap was shown to be intermediate in brain capacity and other features, the teeth were more ape-like, the thigh-bone distinctly human. If, as seemed probable, they all belonged to one species, it conformed very well to the specifications of the "missing link" between man and the higher apes, for which the evolutionists had been hoping, as proof of their contentions.

Naturally this evidence was criticized and discussed, more perhaps than any other fossil specimen. The opponents of evolution declared that it was abnormal, that it was merely a gigantic gibbon, that it was merely a rather small-brained man, that the human thigh-bone did not belong with the skull, that the ape-like teeth did not belong with the skull, that it was too fragmentary to tell us anything worth-while, that it didn't come from the supposed Pliocene beds, but was merely a recent surface specimen washed down by the river, that the beds were not Pliocene anyhow but Pleistocene or recent.

The champions of evolution were equally confident, not merely of the soundness of Doctor Dubois' conclusions, but of the complete accuracy and certainty of the reconstructions and restorations of the Java ape-man built up from them by sculptors and artist-scientists, of his precise position in the ancestral line of the human race, of the length of his hair and the color of his finger nails, and just what he brought home to his wife every night for dinner. No two of the bolder protagonists of either side agreed with each other, but each of them was very certain that he alone was right and all the others partly or wholly wrong, especially about the things he and they didn't really know. Such is the usual course of controversy. The further it is carried, the more absurd become the claims of the zealots of either side.



THE TRAGEDY AT THE SWIMMING HOLE

With a sudden swirl of water the crocodile darts out from under the bank, seizes the ape-man by the leg, and drags him down to be drowned and devoured at leisure

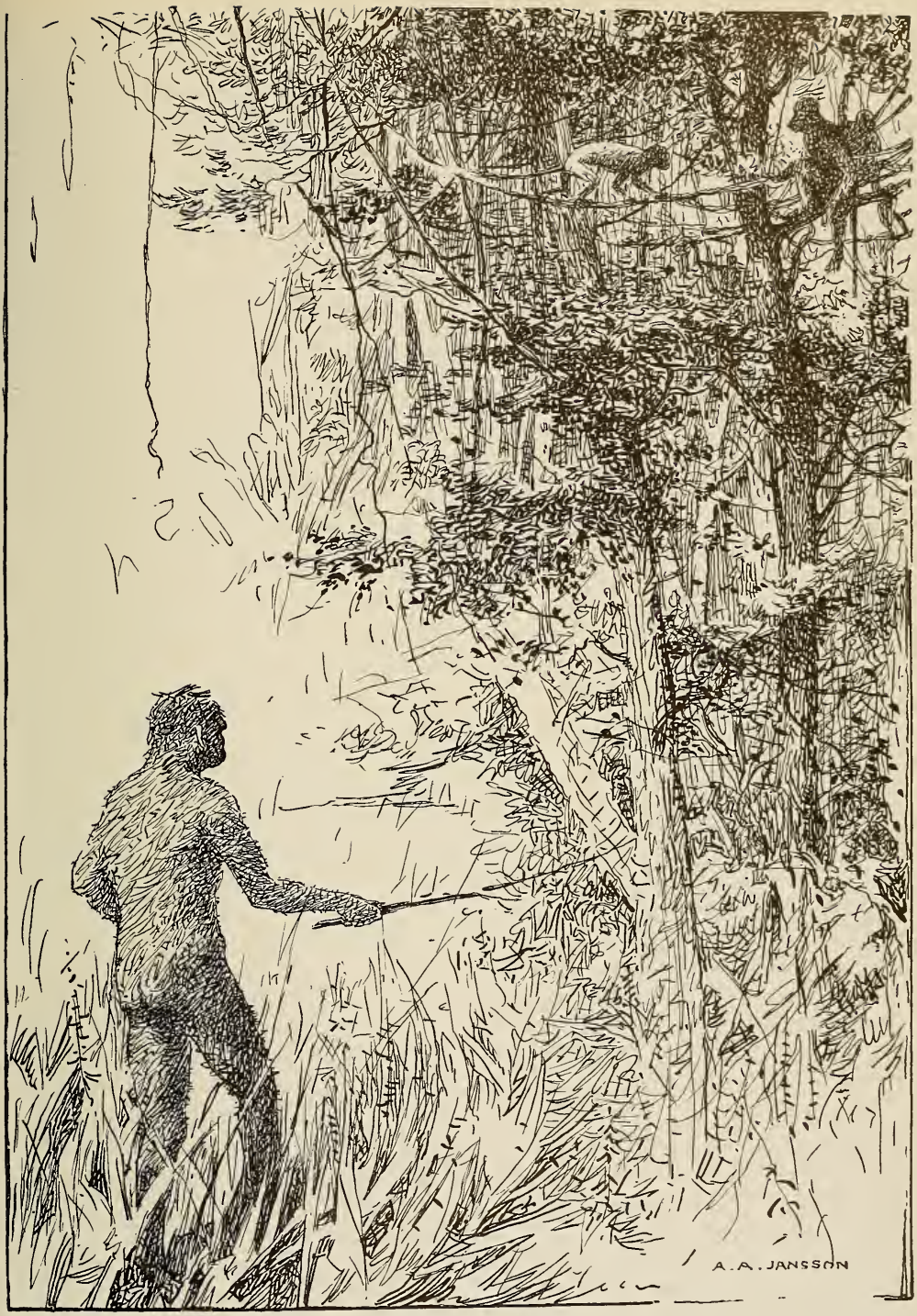
Usually such a controversy is settled sooner or later by further exploration and additional discoveries which show where the truth of the matter really lies. This was what happened to the Neanderthal Man,' first known only from a skull-cap, now from a series of complete skeletons. Even more impressive is the evidence for the evolution of the horse, first sketched out from few and fragmentary specimens, now known from many finely preserved skeletons representing every stage in its fossil record.

But surprisingly little has been added to the fossil evidence for the existence and characters of *Pithecanthropus*. Partly this is because the discovery was not a casual find on the part of Doctor Dubois, but came as the culmination of an energetic and wide exploration over two years' time of the Tertiary and Pleistocene formations of the island, in the course of which he made an enormous collection of its extinct animals and some other interesting but little known remains of fossil man. Partly it is because the island is far away from the principal centers of scientific research and further exploration is difficult and expensive.

A German expedition under Madame Selenka in 1910 worked for two summers at and near the locality; and the Geological Survey of Java has in recent years made search at two or three other promising localities, and has studied and mapped the formation in which the famous fossil was found. But although large additional collections of fossil animals and plants have been obtained, and much new evidence as to the age and geological relations of the formation, no additional remains of *Pithecanthropus* have come to light except two teeth found by the Selenka expedition.

The formation is the topmost member of a great anticline or uplift of Tertiary rocks that extends along the northern side of the island, but the age of the bone-beds is now considered as more probably early Pleistocene, at the beginning of the Glacial Period, instead of Upper Pliocene, just preceding it. The writer of this article had the privilege of spending two weeks as the guest of the Geological Survey of Java in company with one of its ablest geologists, Dr. L. J. C. Van Es, going over the principal exposures of this formation, and is confident that an adequate and well-planned search would bring to light not only a great series of fossil remains of the fauna with which our *Pithecanthropus* lived, but also more and better evidence of the "Missing Link" himself. Two years ago it was reported in the newspapers that a second skull had been found, but this specimen, when examined by scientists, turned out to be a fragment of the head of the humerus (upper arm bone) of a fossil elephant (*Stegodont*), the rounded convex form of which had suggested to the discoverer that it was a human skull.

One very interesting fact has been brought out by later exploration and research. The fossil animal remains found in this formation are quite nearly related to the Upper Siwalik fossils of northern India, a classic and well-known fauna generally regarded as being of Upper Pliocene age, but by some authorities placed at the base of the Pleistocene. The Java fauna corresponds to a part only of the Upper Siwalik. It lacks the horses and camels and most of the antelopes—animals adapted to open plains and deserts. But the elephants and stegodons and mastodons, the hippopotami and rhinoceroses, the cattle and deer, the gigantic tortoise and other less conspicuous mammals and reptiles appear to be closely related to those of northern India. Furthermore, the geological studies of the islands and seas north and west of Java make it probable that in the Pliocene and early Pleistocene much of this area was continental, and that the long anticlinal ridge on the



MEDDLING CURIOSITY

The ape-man exchanges missiles and abuse with a troop of monkeys in the tree tops

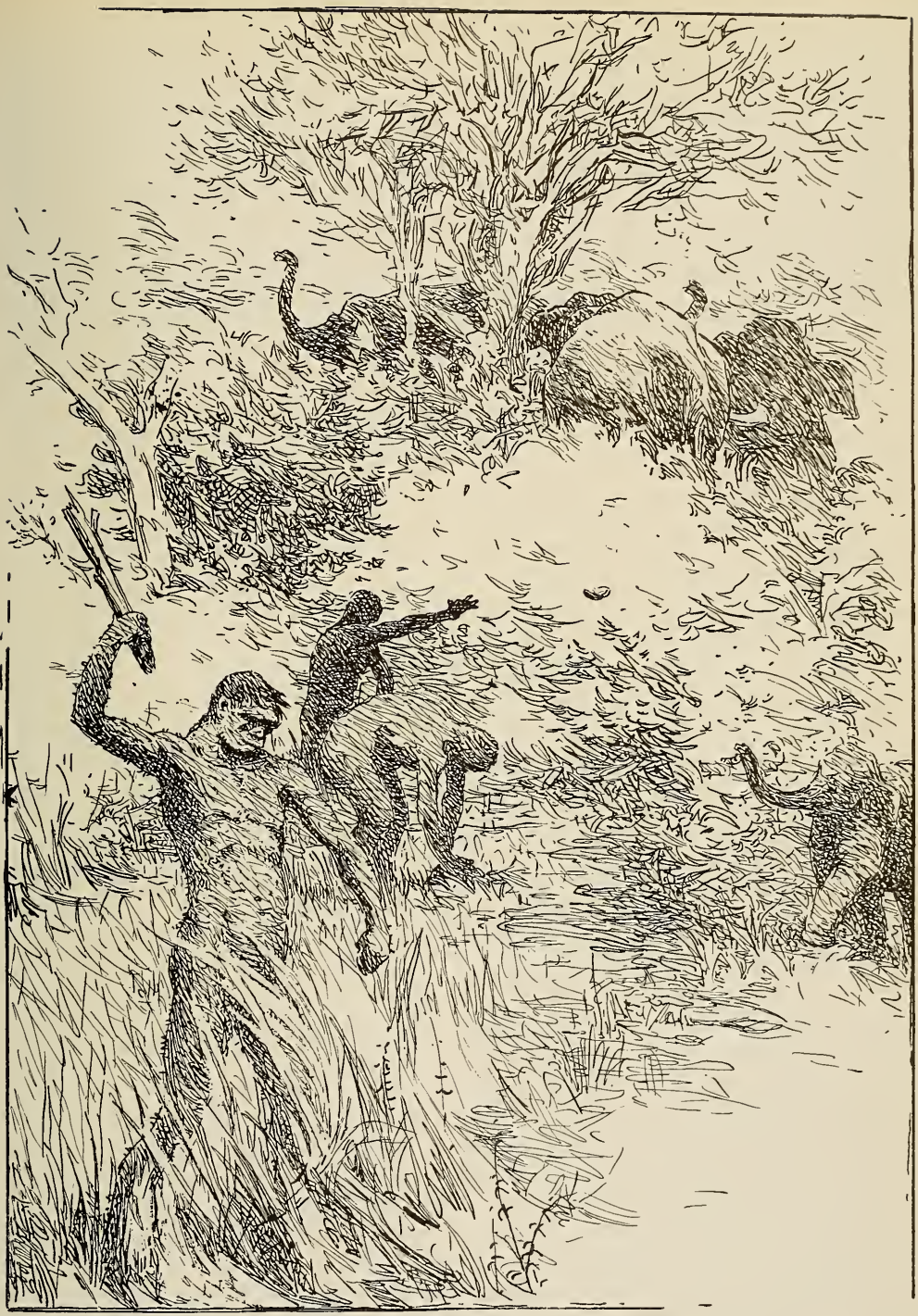
northern side of the island was then the southern boundary of a continental land where now is the shallow Sunda Sea, while the great range of volcanoes on the southern side of Java had not yet arisen from the deep abyssal ocean that lies to the south of the island.

Probably then the fauna with which our *Pithecanthropus* lived had come from far to the north, from central or eastern Asia, leaving behind those races adapted to plains or desert, only the animals suited to jungle and tropical forest being able to make their way to the well-watered and densely forested region of Malaysia. Did the *Pithecanthropus* accompany them from India? That we do not know, for no remains have been found in the Siwalik which can be attributed to him. But it is suggestive that in the preceding formations of Lower Pliocene and Upper Miocene age various fragmentary remains have been found, considered by Doctor Gregory and other careful students as repesenting the common ancestor of man and the higher apes, and of this *Dryopithecus* more remains have been found in northern India than in all the rest of the world. It seems reasonable to conclude from the evidence that the *Pithecanthropus*, whatever his exact relationship to the *Dryopithecus* on one side and to man on the other, had originated somewhere in central or southeastern Asia and made his way to what is now the island of Java about the end of the Tertiary period or while it still was part of the mainland, in company with that great assemblage of animals that we call the Upper Siwalik Fauna.

How much do we really know about what the *Pithecanthropus* was like? How much of the restoration is certain or highly probable, how much is doubtful or speculative? Do we really know anything at all about his habits, or is that "just guesswork," as Mr. Bryan said of the whole theory of evolution. Well, the answer here turns first upon the correlation of parts in the anatomy of animals, on which Cuvier insisted so strongly a century ago; second upon whether the skull-cap, teeth, and thigh-bone belong to the same species. The skull-cap definitely and unmistakably belongs to a higher primate, an anthropoid intermediate between the higher apes and man, and about as near to the one as to the other. The brain-case shows that the brain was about half-way between those of anthropoid apes and man in size and in structure (they are all astonishingly alike in everything except relative size). As far as his brain goes, our *Pithecanthropus* is definitely and directly proven to be a half-way stage between man and ape.

Cuvier's law of correlation, verified by a century of study of skeletons of modern and extinct animals, makes it reasonably certain that the construction of the rest of the skull, and of the soft parts that covered it, was also that of all other higher primates, that is to say somewhere between the extremes shown in gorilla and man. It does not at all follow that because the brain-case is half-way between the two, all the other parts of the skull, jaws, or skeleton are half-way. That in fact is an extreme improbability, and conflicts also with the evidence of the teeth and of the thigh-bone. The probabilities really are that the *Pithecanthropus* was in some respects nearer to man, in others to one or another of the great apes, and had likewise some peculiarities of its own. The character of the teeth would suggest that it had more of the powerful, projecting, heavy-tusked jaws of the ape than the small, rounded jaws of man. On the other hand, the femur, (thigh-bone) remarkably like that of modern man, suggests to everyone, as it did to Dubois when he named the species, the long straight legs and erect gait of our own species.

Do the teeth and femur really belong to



A HEATED INTERVIEW

At the pool the three ape-men pelt a family of elephants with heavy stones until, bruised and terrified, the animals rush off down the trail and vanish in the distance

Pithecanthropus? That is not certain. But if not, then there were two or else three extinct species of higher primates living at the same place and time in Java, and one fragment of each just happened to be entombed in the same layer and only a few feet apart. That is possible, but until there is some evidence that it is true, it is simpler to assume that they all belonged to the one species.

If we start from this postulate, we can make three inferences about our Java ape-man, the first as a certainty, the second and third as probabilities.

(1) The type of mind and manner of thinking and acting was that of the higher apes and man, and his intelligence about half-way between the two. Anyone who has followed the recent psychologic experiment on chimpanzees cannot fail to see the very human way in which their minds work. But in degree of intelligence they are children. *Pithecanthropus* had also the mind of a child, but of an older or more intelligent child.

(2) The teeth, so far as known, are ape-like, not manlike. The inference may be drawn that jaws and teeth as a whole were like those of the great apes, massive, projecting, squared, with prominent canines and relatively powerful front teeth. This construction, as Gregory has shown, is only incidentally useful for fighting, and primarily intended for breaking and crushing large solid-shelled fruits which are common in the tropical forests of the Old World. In other words, it is an adaptation to vegetarianism, and the weak, reduced jaws and small front teeth of man are an adaptation to a diet of meat and small grains—the food of the temperate and northern plains, as the heavy-shelled fruits are of the tropical forest. It appears probable, then, that *Pithecanthropus* lived like the gorilla, chimpanzee, and orang, chiefly upon fruits and nuts, and was not a meat- or grain-eater. With such similar food habits would inevitably go a similar habit of mind to the modern great apes, diverse in many details from the mind of primitive or savage man.

(3) The long, straight leg, quite human in type, indicates a terrestrial, not a tree-dwelling habit,—an erect gait much like our own. While it does not exclude climbing trees, it does rather definitely indicate a normal upright gait. With this, as with the supposed food-habits, we may associate certain mental reactions. The arboreal animal is at home in the trees. On the ground he is awkward and clumsy, indisposed to venture far from his natural refuge, and quick to seek shelter there from any form of danger. The terrestrial animal is more ready to venture into the open, more able to escape by running, prefers to dodge behind a tree for shelter and observation rather than to run up it, and is likely to climb for safety only when attacked by strictly terrestrial enemies.

Our *Pithecanthropus* is a boy in the forest, not a monkey, though he has the monkey's superior interest in fruits and relative indifference to small animals. His size, equalling that of a tall man, plays an important part in his attitude toward other animals. A far more important factor, had we any line on it, would be his social habits—whether largely solitary, or combined in small family groups or in larger clans or tribes. I have assumed a simplified human grouping, a small tribe with subgrouping by sex and age, but this is pure assumption, necessary because you cannot draw a picture without it; just as you have to give an extinct animal some pattern of color and hair, although whatever you adopt is probably wrong.

Photograph by Roy Waldo Miner

STORMS AND STORM TRACKS

A Brief Statement of the Origin, Development, and Movement of Thunderstorms, Cyclones and Anticyclones, Tornadoes, Waterspouts, Hurricanes, and Typhoons

By CHESTER A. REEDS

Curator of Geology and Invertebrate Palæontology, in the American Museum of Natural History

The winds grow high;
Impending tempests charge the sky;
The lightning flies, the thunder roars;
And big waves lash the frightened shores.
—Prior.

THE late West Indian hurricane, which left destruction in its wake in the Windward Islands, Porto Rico, the Bahama Islands, and Florida, and which passed northward across the United States to the vicinity of James Bay, Canada, before turning eastward, calls special attention to hurricanes and the various other types of cyclonic storms, as well as to their storm tracks.

Storms may be local, such as the thunderstorm, or they may be great whirling masses of air oftentimes a thousand or more miles in diameter, such as the hurricane, the cyclone, or the anticyclone. They may be mild in character, such as the passing shower, or violent like the tornado and the hurricane.

Thunderstorms have been more generally observed than any other storm. They occur in nearly every part of the world, but the number decreases rapidly from the equator toward the pole. Thunderstorms are caused by the sudden rise of a large mass of moist warm air, hence they are common in the tropics and frequent in temperate latitudes during the summer, while over the sea in high latitudes they occur during the winter. The body of moist rising air cools, due to expansion, reaches its dew point, and builds the immense cumulo-nimbus cloud, the rain cloud, which in cross-section may be anvil-shaped in appearance and occupy a space from one to four miles in height and forty to seventy miles from front to back when well developed. These clouds yield an abundant precipitation, a marked drop in temperature, and an outrushing violent squall wind which just precedes the rain. It was formerly thought that thunder and lightning, which accompany such storms,

produced the storms, but it is now known that they are not the cause, but are secondary features and result from the condensation of the cloud.

The path of a thunderstorm is frequently pear-shaped, the beginning being but a few miles long and a mile or two wide. As the storm develops and moves forward, it becomes constantly larger, so that at the end of six or seven hours it has a front one hundred and fifty to two hundred miles long by some forty miles wide. Some thunderstorms last for more than twelve hours, and cover territory about five hundred miles long by as many miles wide at the terminal end. The average velocity of these storms for the United States is from thirty to forty miles an hour, while in Europe it is between twenty and thirty miles.

Thunderstorms are most frequent in the late afternoon or early morning. Regionally they are most numerous in the humid parts of the tropics where several occur each week during the rainy season. They are rare, but not unknown, in polar regions, and are rare in the deserts and in the trade-wind belt of the ocean. In the United States they are most frequent in the humid southeast and less frequent along the Pacific coast where little of the rainfall occurs in summer. In the temperate and tropical zones most of the severe thunderstorms are associated with cyclonic depressions.

A cyclone is a system of winds blowing toward a common center. The name was first suggested by Piddington early in the Nineteenth Century. It is derived from the Greek word for circle, hence it embodies the idea of a circular or spiral movement of the winds. An anticyclone is a system of winds flowing outward from a common center. The name was proposed by Galton in 1863, and means the opposite of cyclone.

P. and A. Photos

LIGHTNING FLASHES DURING A THUNDERSTORM

The lightning in a storm becomes more frequent and more severe as the rain increases

Photograph by Brown Brothers

A THREE-MASTED SCHOONER GOING DOWN AFTER A STORM AT SEA

The sinking of this vessel in mid-ocean as the result of a severe storm is typical of the days of the "clipper ships," when hurricanes were not so well understood as now. Note the only survivors leaving in a small boat at the stern of the sinking ship

It may be observed on a weather map, or a barometer, that the wind circulation in a cyclone and in an anticyclone is controlled by areas of low and high barometric pressure, respectively. This was first noted by Buys-Ballot, a Dutch meteorologist. His observation has become a law, which holds true for the Northern Hemisphere, and may be stated as follows:

Stand with your back to the wind, and the barometer will be lower on your left hand than on your right.

Pressure is thus one of the most important elements controlling the movement of storms. It is determined by a mercurial barometer, an instrument that registers in hundredths of an inch the number of inches of mercury the weight of the air holds up in a glass tube. Unlike the temperature, or the wind, the pressure of the air cannot be determined by our own senses without instrumental aid. When plotted on a map, lines of equal barometric pressure, called isobars, may be developed. They are of service to meteorologists in locating storm areas, in tracing their movements, and in forecasting the weather.

The examination of an isobaric chart of the world will show the presence of great oval areas of low and high pressure covering a whole continent, or a whole ocean, and keeping about the same position for months at a time. Teisserenc de Bort (1887) called these areas "centers of action." For instance, on an isobaric chart showing the mean pressure over the world in January, there are immense areas of high pressure (anticyclones) over the great land masses of the Northern Hemisphere with spirally outflowing winds, and immense areas of low pressure (cyclones) with spirally inflowing winds over the North Pacific and North Atlantic oceans. In July the barometric conditions are reversed for the northern continents. This replacement of the high pressure of

winter by the low pressure of summer is due to the continental areas being alternately colder in winter and warmer in summer than the adjacent oceans.

When there comes a change, in any region, from low pressure to high pressure, or *vice versa*, the system of winds in that region will also change. Many such changes of pressure and winds actually occur in different parts of the world, and are of great importance in tracing the movements of storms and interpreting the climate. The best-known of all these changes occurs annually in India. During the winter an anticyclonic area of high pressure is central over the continent of Asia. The winds blow out from it on all sides, thus causing generally northeasterly winds over the greater portion of India. The winds are prevailingly dry and clear, and the weather is fine during the time they blow. India then has its dry season. As the summer comes on, the pressure over Asia changes, becoming low; a great cyclonic area replaces the huge winter anticyclone, and inflowing winds take the place of the outflowing ones of the winter. The summer winds cross India from a general southwesterly direction. They come for long distances from over the Indian ocean, and are thus moist and rainy. India then has its rainy season. These seasonal winds are known as monsoons, a name derived from the Arabic, and meaning seasonal.

The ceaseless changes in the weather of the temperate zones are due almost entirely to the approach and passage of smaller cyclones and anticyclones, the "lows" and "highs" respectively, which appear on daily weather maps of the United States Weather Bureau and those of other nations. They are secondary pressure disturbances which arise in the

Photograph by Brown Brothers

A SQUARE-RIGGED SHIP AGROUND ON THE NEW JERSEY COAST

This sailing vessel was driven off its course by a sixty-mile-an-hour gale to founder in water too shallow to float it. Stuck fast in the sands of the beach, it is being pounded to pieces by the waves. The depth of the trough to the right of the vessel shows that a high sea is running

Photograph by Brown Brothers

A WATERSPOUT OFF THE COAST OF MASSACHUSETTS

The funnel-shaped vortex of this waterspout is long and slender and slightly curved; at the base of the dark cloud and where it touches the calm sea, it has a greater diameter than in its mid-section. Like the tornado and the hurricane, the waterspout is a violent and destructive type of storm, and its path should be avoided where possible

general circulation of the atmosphere and should be differentiated from the sub-permanent oceanic and continental areas of low and high pressure, or "centers of action," noted above. Where westerly winds prevail, these "lows" and "highs" move from west to east and greatly affect the weather. In 1885–1887 Loomis, of Yale, made an extended study of the form and dimensions of these areas. He found the average form of the areas of low pressure to be elliptical, the longer diameter being nearly twice as long as the shorter (ratio 1.94:1) with the direction of the longer diameter to be about N.E. (N.36° E.), and the length of the longer diameter often 1600 miles. In the case of high pressure areas an elliptical form was also found to predominate, the longer diameter being about twice as long as the shorter (ratio 1.91:1), and the direction of trend about N.E. (N.44° E.). These characteristics also hold, in general, for the cyclonic and anticyclonic areas of Europe. The cyclones of the tropics differ considerably from those of temperate latitudes in being nearly circular in form.

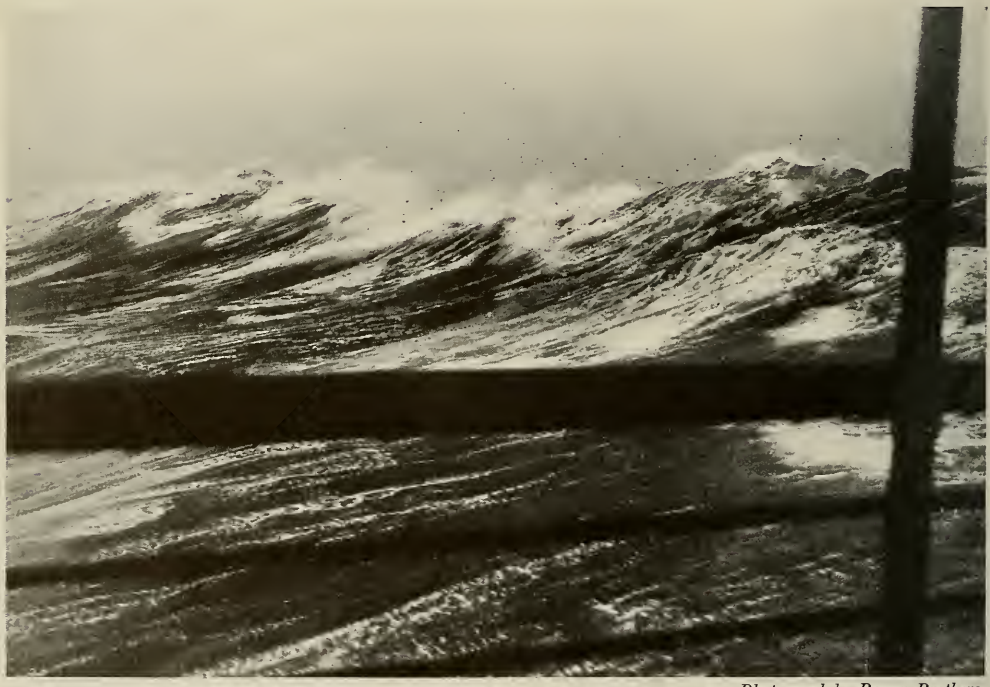
The chief characteristics of a "low," as noted on our weather maps, may be summarized as follows: The spirally inflowing winds turn counter-clockwise in the Northern Hemisphere, and clockwise in the Southern; the wind velocity is generally moderate, being strongest in the southwest quadrant; the pressure varies from 30 inches at the margin to an average of 29.6 inches at the center, although in some cases it may drop to below 28 inches; the temperature is high in the south and east sides of the storm, where the winds blow from a southerly quarter, and low on the west side, where

the winds blow from a northerly quarter; the clouds cover the eastern half of the storm area; the cirrus clouds, which occupy higher levels, extend far out to the east, while the nimbus or rain clouds are located chiefly in the southeast quadrant. The whole area may vary in diameter from a few hundred miles to several thousand miles. In the United States it moves from west to east, at an average hourly rate of 34.2 miles in February, 22.6 miles in August and 28.4 miles for the entire year, according to Loomis.

A "high" area is intimately associated with a "low" area and usually follows it. The chief elements of a "high" are these: The spirally outflowing winds turn clockwise in the Northern Hemisphere and counter-clockwise in the Southern; the wind velocity is usually moderate and decreases toward the center where calms are frequent, especially at night; the pressure varies from about 30 inches at the margin to about 30.6 inches at the center, although at times it is more than 31 inches; the changes in temperature are great and well marked, being low in the northeast portion, where the winds are from the north, and high in the southwest and west portions, where the winds are from the south; the moisture changes are similar to those of the temperature; few clouds are to be seen and precipitation is usually lacking; the humidity is low in the northeast portion and high in the southwest. Like the "low," the "high" area is from several hundred to several thousand miles in diameter and moves with moderate velocity from west to east.

In the Northern Hemisphere the "low" and "high" areas move eastward and slightly poleward. This is due to the prevailing direction of both the surface winds and the fast upper air currents in these latitudes. They thus drift with the general wind system.

The main track of these storms follows the northern boundary of the United



Photograph by Brown Brothers

A STORM WAVE SEEN FROM A SHIP'S DECK

Illustrations Bureau *Photograph by Brown Brothers*

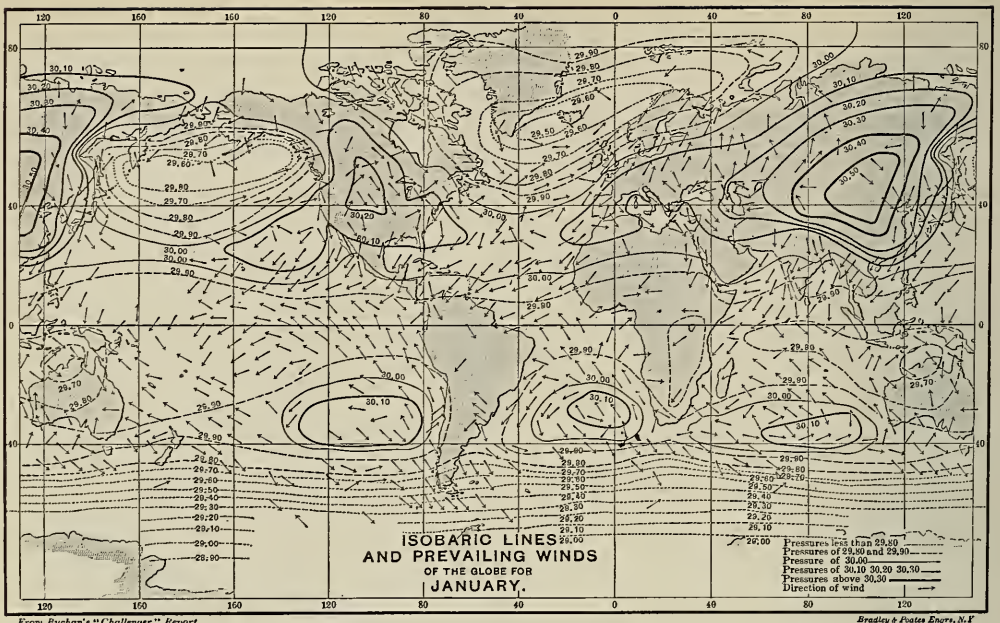
WRECK OF A STEEL SHIP ON THE COAST OF IRELAND
This broken and twisted hulk, resting upon the channeled and wave-swept old rocks of the Irish coast, bears mute evidence of the power of the sea in storm

States, across the Great Lakes and out the St. Lawrence valley. The crossing of the United States is made in three to four days. Other tracks from the southwest and south join the main track over the Great Lakes. Still another track comes up the Atlantic coast and joins the main track near Nova Scotia. A second main track is observed by some meteorologists as passing in over southern Oregon and moving southeast across Oklahoma and the eastern Gulf States to the Atlantic coast, where it turns northward or continues out over the ocean.

Another type of storm is the tornado. It is a local whirlwind possessing great energy. In fact, it is a tiny cyclone characterized by very low pressure at its center, and winds of destructive violence over a belt a quarter of a mile in diameter on the average, with a track varying from a few miles to some thirty miles in length. The name is derived from the Spanish and refers to the twisting or rotating nature of the storm. It usually develops in the southeast quadrant of a "low" which has a V-shaped bulge to the southwest with a crowding of the isotherms and isobars, known as a windshift line. A tornado usually arises two hundred to eight hundred miles south or southeast of the center of a "low" with sultry, moist, southerly winds bearing heavy clouds.

It is always associated with a violent thundershower, which is usually accompanied by hail, a pronounced squall wind, and violent thunder and lightning. It occurs almost exclusively during the warm months of the year, and during the hottest part of the day.

The most invariable feature about a tornado is the peculiar black funnel-shaped cloud which extends downward from the bottom of the heavy cloud masses. The funnel is developed around the axis of a violent ascending vortex of whirling



Map by W. M. Davis *Courtesy of Ginn & Co.*

CHART SHOWING DISTRIBUTION OF MAIN AREAS OF HIGH AND LOW BAROMETRIC PRESSURE AND PREVAILING WINDS OF THE GLOBE FOR JANUARY. (FROM DAVIS' *Elementary Meteorology*, AFTER BUCHAN.)

winds; its diameter may reach a few hundred feet while the destructive winds around it cover a somewhat greater area. Wherever the funnel touches the earth's surface, it causes complete devastation.

Before the formation of the funnel, the clouds have a black appearance, and seem to be in violent agitation. Then the black funnel appears, which normally drops lower and lower until the surface of the ground is reached. Here it enlarges slightly so that some authors have described the tornado cloud as having the form of a dumb-bell. It may sway from side to side and often writhes and twists. Sometimes it lifts, only to touch the ground again farther on.

In 1902 the writer witnessed, at close range, the development and disappearance of a tornado over Norman, Oklahoma, which did not reach the ground. The V-shaped funnel appeared at the base of the black cloud and dropped about one quarter the distance to the earth, then it rose into the cloud. This dropping and raising of the funnel was repeated four times before it finally disappeared into the cloud. With each successive drop of the funnel the writhing lower end approached nearer and nearer the buildings of the city, but it did not strike and no damage was done. The storm moved from southwest to northeast and passed over Norman within ten minutes. A tornado may pass a given point in less than half a minute, but this is sufficient for complete destruction.

The destruction is due to two causes:

(1) The excessive wind velocities within the funnel.

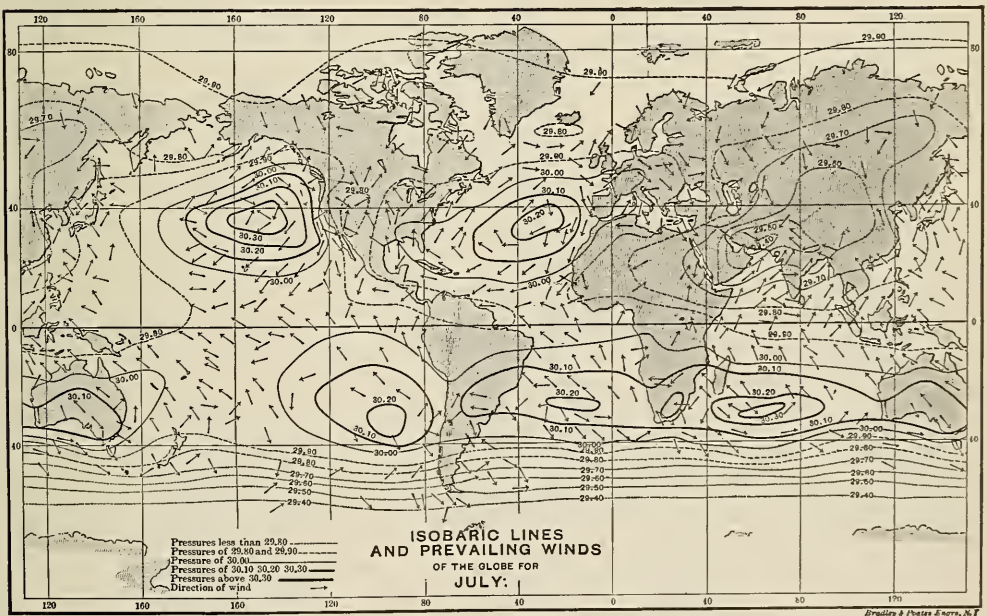
(2) The explosive action resulting from the sudden decrease of the barometric pressure induced by the passage of the tornado. The barometric pressure is normally 14.7 pounds per square inch, but when this is suddenly reduced several pounds outside of objects containing air, for example a house, the normal pressure

inside literally raises the roof or forces the windows open, or causes the side walls to fly apart.

Tornadoes perform weird feats: trees may be uprooted, stripped of their branches, or torn off at various elevations above the ground; heavy brick and stone buildings may be demolished; roofs have been torn from buildings and carried long distances through the air; loaded cars and even locomotives have been lifted from the tracks; animals, even babies have been picked up and carried considerable distances, and let down unharmed, while many have been killed. Straws have been driven through boards and fence posts; laths through trees, and small sticks of timber through iron plate. Chickens have been stripped of their feathers, corks have been drawn from empty bottles, circular holes have been dug in the ground, and pictures and furniture have been left intact in houses where one or more outside walls have disappeared.

The noise which accompanies a tornado is tremendous; in fact, it is deafening. The roar is constant and so great that the demolition of buildings is seldom heard. The wind velocity within a tornado has never been measured, but it may amount to five hundred miles per hour in the more violent ones.

Tornadoes are of common occurrence in the Mississippi Valley region and certain of the southern states. They are practically unknown in the Rocky Mountain and Appalachian mountain systems. They are most frequent over the Great Plains and the level country to the eastward. They seldom develop in mountainous or forest-covered areas. About one hundred occur annually in the United States, causing the loss of nearly a hundred lives and several million dollars of property. Tornadoes occur also in the great plains section of southern Canada. As noted by Visher (1925) they are probably as frequent and widespread in Australia as in the United States, and are



Courtesy of Ginn & Co.

CHART SHOWING DISTRIBUTION OF MAIN AREAS OF HIGH AND LOW BAROMETRIC PRESSURE AND PREVAILING WINDS OF THE GLOBE FOR JULY. (FROM DAVIS' *Elementary Meteorology*, AFTER BUCHAN.)

rather common in western Africa. Typical tornadoes occur occasionally in Europe, in Fiji, and in the Dutch East Indies, China and Japan, and similar storms develop in South America.

Waterspouts are tornadoes that occur at sea or over inland bodies of water. They are most common over the warmer and calmer seas, and may be associated with violent thunderstorms. When the funnel reaches down to the surface of the sea, the water becomes greatly disturbed, and it may rise a number of feet within the funnel. The water in the upper portion of the funnel has been found by observation to be fresh and is a product of condensation from the cloud above.

Waterspouts like tornadoes and hurricanes form true vortices with greater velocity of rotation in the central portion than on the margin. The vortex tubes are arranged in geometrical ratio and, although packed closer and closer together toward the center, each tube carries the same amount of air upward. They are very destructive near the central axis.

Another type of storm is known as a tropical cyclone which may develop into a hurricane or typhoon. It is similar in many respects to the "lows" or cyclones of middle latitudes. Both are characterized by central areas of low barometric pressure toward which the winds blow more or less spirally; both are accompanied by cloudiness and local precipitation; both move rather slowly in a more or less characteristic direction; both vary greatly in intensity; both occur in all months of the year, but are more frequent and stronger in one season than in another.

P. and A. Photos

WRECKAGE AT WEST PALM BEACH, FLORIDA, DURING THE HURRICANE OF SEPTEMBER 16, 1928

This hurricane, which was first reported by ship radiograms some 600 miles east of the Windward Islands, passed over Porto Rico, the Bahama Islands, Florida, along the Carolina coast to Wilmington, and then northward over Buffalo to James Bay. Immense damage to property and great loss of life were reported from Porto Rico and Florida

Photograph by Miss Lusille Handberg *Courtesy Wide World Photos*

TORNADO PASSING SHERMAN, SOUTH DAKOTA, JULY, 1928

The inclined funnel of this tornado is long and sinuous. It is interesting to note that to the left of the house and directly over it the light and dark bands represent various pressure tubes in the vortex of this terrible phenomenon. Below the constricted central portion the wind blows spirally inward and upward; above, spirally upward and outward, forming the bulge at the upper end

Some tropical cyclones cause merely slight changes in the weather; others are accompanied by strong winds; still others by gales; and a lesser number by winds of hurricane force.

Tropical cyclones, however, differ from the "lows" of middle and high altitudes in several respects. On the average they are more intense and gales are common. They usually move westward or northward and out of the tropics, while mid-latitude cyclones practically never move westward nor into the tropics. Tropical cyclones are smaller, averaging about three hundred to four hundred miles across. They also move more slowly, their average rate being about three hundred miles a day, although some move one hundred miles a day and a few four hundred to five hundred miles. Another difference is that tropical cyclones have an "eye"—a calm central area with a diameter of ten to twenty miles. Few cyclones of mid-latitudes have an "eye."

Tropical cyclones differ from tornadoes in that few tornadoes are destructive over a belt wider than a quarter of a mile and longer than thirty miles, while hurricanes and typhoons may cause great damage throughout a belt several hundred miles wide and a thousand miles long. Instead of twisting off trees and demolishing buildings as the well developed tornado does, a hurricane usually uproots a few trees, breaks off branches and strips off the leaves, and generally demolishes only the less substantial houses. Tornadoes are most frequent in spring and early summer; tropical cyclones may occur every month of the year, although most of them develop during the summer and autumn.

Although the most striking characteristic of tropical cyclones is the strong winds spiralling toward the center, the destructiveness of these storms is only in part due to the winds. Waves produced by the wind engulf boats, break them or drive them upon the shore, and may do great damage upon low-lying coasts. Wall-like waves five or ten feet in height, advancing far up the streams, may drown people far from the sea. The destructiveness of the waves along the shores is greatly increased by the rise in the sea itself, which occurs near the center of the storm, due both to the wind-driven water of the inrolling waves, and, in a lesser degree, to the partial vacuum at the center. In fact, the sea itself is sometimes raised more than ten feet, and waves reach heights of twenty feet or more above normal sea level. A striking example occurred during a typhoon at Mille; latitude 8° N. in the Marshall Islands, June 30, 1905, when waves rose forty-six feet above sea level. Low-lying lands have repeatedly been overswept by hurricane waves. Reports indicate that the only surviving residents of certain low islands were persons who had climbed palm trees and tied themselves there. The late Jack London in one of his South Sea tales, *The House of Mapuhi*, describes vividly the development of a hurricane and its sweep over low-lying islands peopled with pearl-diving fisher folk.

P. & A. Photos

A CLUB-SHAPED TORNADO SWEEPING ACROSS THE PLAINS NEAR CHEYENNE, WYOMING

The dust-whirls about the dark, bulging, lower end of this tornado are noticeable, while a short distance away the air is apparently calm. This scene is unusual in that the smallest diameter of the funnel is at the base of the dark cloud

Visher (1925) notes that when the barometric pressure at the center of a hurricane is less than twenty-eight inches, the sea level is raised about two feet. Consequently, when the center of a hurricane strikes a low coast at the time a high tide is coming in, the effect of the waves is intensified.

Another cause of destruction by tropical cyclones is the downpour of rain commonly associated with these storms. As much as twenty inches of rain may fall in a day or two, while the storm is passing. As a result, small streams swell into dangerous torrents, and much low-lying land is flooded, causing the death and impoverishment of many people.

Tropical cyclones develop in the doldrums, usually within latitudes 10° to 25° north and south of the equator. Those in the Northern Hemisphere move northwest through the trade-wind belt with a velocity varying from six to twelve miles an hour. They curve to the right in about 28° to 30° north latitude and move north or northeast through the region of the prevailing westerlies. As they move forward, they grow somewhat larger and the velocity of motion rises to twenty, thirty, or sometimes forty miles per hour. A few excerpts from ship logs give a faint idea of the power of the sea in a tropical storm.

On August 23, 1913, the American four-masted schooner, "Robert Searles," encountered a storm one thousand miles southwest of Mazatlan,

Mexico. At 2:00 A.M. of the 24th the glass began dropping; all hands started to shorten sail. The storm came on rapidly and at 6:00 A.M. the foresail was blown away. Other sails followed; and at 10:10 A.M. the forestay sails went by the board, leaving the vessel to go broadside to the sea. Heavy waves swept the schooner and, shortly after, the rail davits and Captain Sandberg were washed overboard. Before 5:00 P.M., when the gale moderated, the deck load of lumber, the rudder, all sails, and the fore and main masts had disappeared.

An account by Paul R. Wright of the U. S. Transport "Sherman" gives a vivid picture of a typhoon in the China Sea, September 1, 1919.

At daylight I was privileged to behold one of the wildest and most sublime scenes that men have ever looked upon and lived to tell about. The storm was at its height. The wind was coming in gusts that reached 120 miles an hour. The air was simply filled with the white spume of the sea, just as the air is filled with snow in a great storm at home. To windward it was impossible to see more than one hundred feet, and to leeward not much farther. Yet through this white welter we could see something of the heights and depths that hemmed us in more than masthead high, with writhing slopes like the sides of mountains.

The wind pitched itself at us with a force that made the gale of the night before seem puny and ineffective. Altogether it was an exhibition of violence unsurpassed. The nearest approach to it is afforded by Niagara Falls, as you ride up to the foot of the tumbling waters in the "Maid of the Mist," or walk under them to the "Cave of the Winds." But here both air and water were like a Niagara let loose and driving themselves down upon our little steel ship. Against the unprotected face the hard driven spume stung like the flying particles of a sandstorm. It was terrible and magnificent. At eight o'clock the barometer reached its lowest mark and stood at 28.58. From this point the mercury rose steadily and the wind tended to abate. The humming reverberation of the ship under the pounding seas gradually lessened and the general strain was relieved before nightfall.

The regions chiefly subject to tropical cyclones are:

(1) The West Indies, the Gulf of Mexico, and the coast of Florida.
(2) The eastern north Pacific.
(3) Central north Pacific.
(4) Western north Pacific.

Wide World Photos

TORNADO AT VULCAN, ALBERTA

The dark vertical funnel of this tornado is dumb-bell-shaped, with its smallest diameter a short distance below the mass of dark, seething clouds. It was so dark overhead that objects on the surface of the ground appeared in silhouette against the gray sunlit sky beneath the storm

(5) Western south Pacific.
(6) Australian region.
(7) South Indian Ocean.
(8) Arabian Sea.
(9) Bay of Bengal.

The total annual number of tropical storms occurring in these regions as noted by Visher (1925) are as follows:

Cyclonic disturbances	74
Lesser hurricanes and cyclones	60
Hurricanes	39

The characteristics of various types of storms, their rate of movement, occurrence, and the paths which they follow, have been noted in previous pages. A brief discussion of matters of more general import follows:

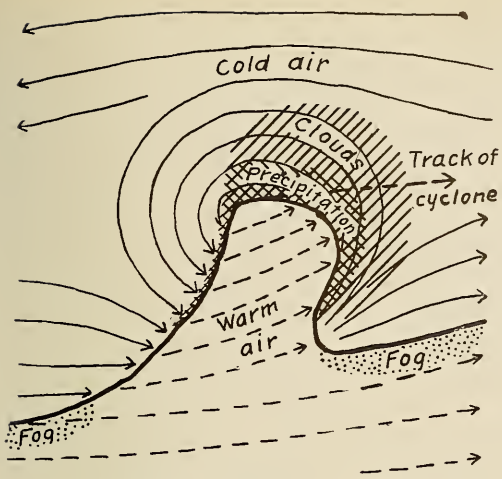
Two hypotheses have been advanced to explain the manner of origin of tropical cyclones, namely: the mechanical and the convectional. The first and older theory holds that these whirling storms are set up by friction between opposing currents of air. The opposite conception treats of the conveyance of heat from one atmospheric region to another by currents of air and water due to their specific capacities for heat, or, by the freeing of the latent heat of vaporization when the aqueous vapor condenses. The mechanical view was proposed about one hundred years ago, the convectional in 1841. Each hypothesis has been supported by eminent meteorologists, and modifications have been made on both sides to meet the increase in knowledge. Some meteorologists even hold that both agencies contribute to the formation of these storms.

An important relation exists between the "low" and "high" areas of barometric pressure, which cross the United States from west to east in three to four days, and the larger pressure areas or "centers of action" known as the Aleutian and Ice-

P. & A. Photos

A 1901 TORNADO ABOVE NORTON, KANSAS

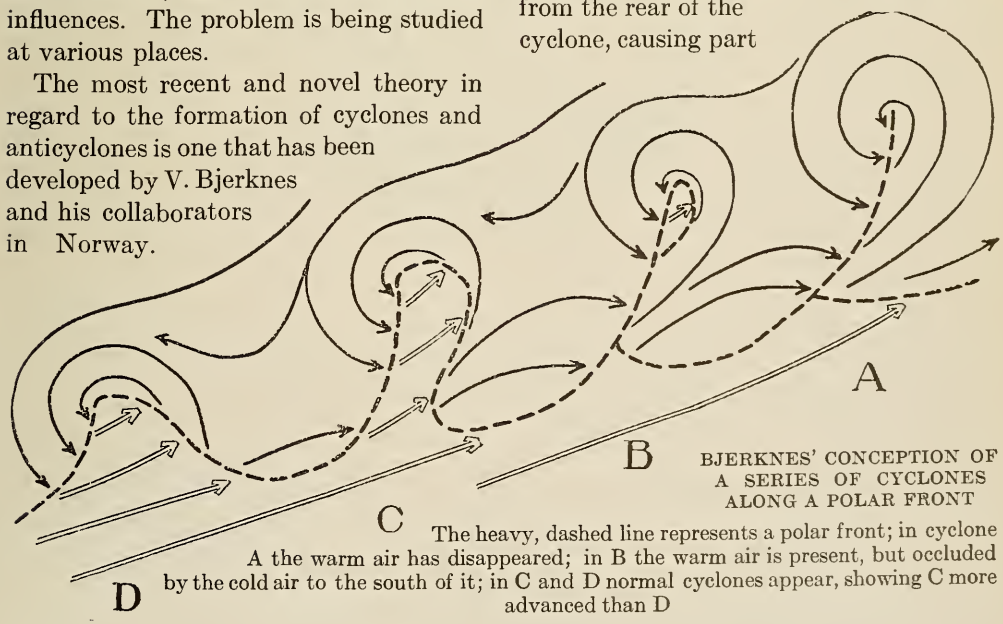
Another unusual photograph, showing two funnels, one above the other. The lower one is more or less transparent and partakes of the nature of a dust-laden whirlwind. The upper dark cone, just appearing, is filled with condensed vapor. Both cones united before the storm was over



Plan of the relations of warm and cold air currents in a cyclonic storm. (After Bjerknes)

land lows, the "highs" over the mid-latitudes of the Atlantic and Pacific oceans and, in the winter months, the "highs" over Siberia and North America. When the pressure in these larger areas is abnormal, marked differences arise in the normal weather, and in the temperature conditions in the United States. Some meteorologists assume that these abnormal distributions of pressure are due to extra-terrestrial, and others to terrestrial influences. The problem is being studied at various places.

The most recent and novel theory in regard to the formation of cyclones and anticyclones is one that has been developed by V. Bjerknes and his collaborators in Norway. From a study of detailed weather charts he developed the idea that the air strata of different density, most frequently met in nature, are the two great currents, one flowing toward the pole, the other toward the equator. The accompanying drawing, after Bjerknes, shows how these currents act and react to form a cyclone. Here we see that the cyclone consists of two essentially different masses of air, one of cold, the other of warm origin. They are separated by a fairly distinct boundary surface, which runs through the cyclone and which has been designated the line of discontinuity, or polar front line. The whole system propagates with the east-bound current of westerly winds and the cyclonic center with the lowest pressure area. In the Northern Hemisphere the warm air is conveyed by a southwesterly to a southeasterly current on the southern or eastern side of the depression. At the front of this current the warm air ascends the wedge of colder air and gives rise to precipitation in the form of warm front rain. At the same time the warm current is attacked on its flank by cold air masses from the rear of the cyclone, causing part



BJERKNES' CONCEPTION OF A SERIES OF CYCLONES ALONG A POLAR FRONT

The heavy, dashed line represents a polar front; in cyclone A the warm air has disappeared; in B the warm air is present, but occluded by the cold air to the south of it; in C and D normal cyclones appear, showing C more advanced than D

of the warm air to be lifted and precipitation formed as a cold front rain.

Bjerknes has found that the line of discontinuity continues outside the limits of a single cyclone, and that it passes from one cyclone to another. The single cyclone described above thus represents only one stage in the development of the life cycle of a cyclone. Bjerknes has published a series of sketches showing the "life cycle" of cyclones, the formation of a secondary cyclone as a wave on the cold front of the primary cyclone, cyclone families, etc. The series of changes in a cyclone along a polar front are schematically shown in the figure on page 603 by sketches A. B. C. D. He observes that during the first phase of the development of the cyclone, from its origin to the moment of occlusion, that is, when the cold air on the ground in the front and rear of the cyclone join, the warm is lifted by the two wedges of cold air as they gradually approach each other. After the two wedges of cold air have met on the ground, the still existing upper warm sector will be further lifted and gradually cooled to the temperature of the surrounding air, causing the cyclone to fill up or disappear. Before one cyclone is occluded, others begin to form to the westward.

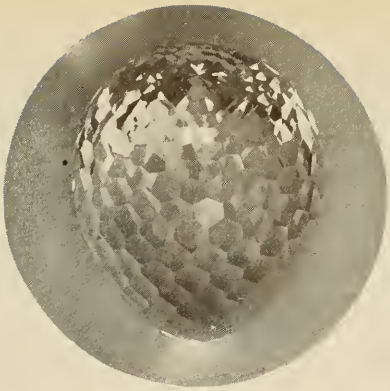
Wide World Photos

A VIOLENT TORNADO SWEEPING ACROSS THE PRAIRIES NEAR OKLAHOMA CITY, OKLAHOMA

This remarkable photograph was made at a distance of two miles from the approaching tornado. It is an unusual view, because the funnel is short and thick and the black cloud descends near to the surface of the ground

On sufficiently detailed weather maps a series of connected cyclones may be observed in temperate latitudes forming a circumpolar whorl. It has also been observed that when the polar air from the rear of one cyclone enters the trade wind belt, the next series of cyclones will appear on a more northerly track and follow a new polar front, which is not connected with the previous one. This periodicity enables us to divide cyclones into groups which have been called cyclone families.

In the opinion of some meteorologists, the theory which has been advanced by Bjerknes at the Bergen Institute in Norway since 1918, represents a decided step in advance. The theory, however, cannot be fully tested under existing conditions of weather reporting. What is required is the establishment of a larger number of observation stations throughout the Northern and Southern Hemispheres, and the development of a more intensive charting of daily weather conditions at the central meteorological stations. With the proposed increased facilities in operation, there would arise a more accurate forecasting of the weather, and a more precise knowledge concerning the origin, development, and movement of storms.



A BLUE TOPAZ

WHAT IS A GEM?

What Qualities Make Some Stones Precious? Why are Diamonds, Rubies, Emeralds, Sapphires, and Others the Culmination of All That Is Fine in Stones?

By HERBERT P. WHITLOCK
Curator of Minerals and Gems, American Museum of Natural History

THE relation of minerals to gems is not always easy for the layman to grasp. If every different kind of mineral furnished a different kind of gem, there would be more than one thousand varieties for the jeweler to remember. In point of fact, only four per cent of the mineral species known to science are suitable for the fashioning of gems. Moreover, in many instances only certain varieties of a particular mineral answer the requirements of a gem stone.

Let us then consider briefly the qualifications which combine to confer nobility, as it were, on the members of the mineral family, because in most cases our most beautiful and precious gems are only distinguished varieties of very common and unassuming minerals.

In the first place, the most obvious quality that a gem should possess is beauty of color. From the rich brilliant red of the ruby through the delicate and subtle shades of tourmaline and chrysoberyl, beauty of color is the source of the appeal exercised by these fragments of Mother Earth.

Linked to beauty of color is a second quality which in most cases determines the question of whether a mineral will qualify as a gem. A certain degree of transparency which permits the color qualities of a gem to be developed by the cutting and polishing of the stone, is a necessary requirement of most gem minerals.

Again, in order to preserve its transparency and polish against the wear to which a stone worn as jewelry is inevitably subjected, a gem mineral should possess a certain degree of hardness. This requirement is particularly rigid for stones that are intended to be mounted in rings, since it is these that are subject to the most strenuous wear.

And, lastly, the desirability of a gem is very largely governed by its rarity. We have ample illustration of this in the single case of the artificially produced sapphires and rubies, which, although possessing all the qualities of the choicest natural gems, beauty of color, hardness, brilliancy, are on account of the ease which they are obtained and their attendant low price, little esteemed among the wearers of gems. Nor does the comparatively low price of these artificial members of the

royal family among gems in any way affect that of the natural rubies and sapphires. Gem purchasers are willing to pay many times the value of a synthetic gem solely for the rarity of the same gem from a natural source.

To sum up, then, the qualifications which determine whether a certain mineral or a special variety of a mineral will furnish material for gem stones, we have:

1. Beauty of color
2. In most instances transparency
3. A certain degree of hardness
4. Rarity of occurrence under these conditions

Just what is the difference between a precious and semiprecious stone? This question is very often asked and is not altogether easy to answer. The difference, although mainly one of value, is complicated by several considerations. In the first place, a gem mineral such as beryl furnishes us with the highly desirable gem, the emerald, and also with the semiprecious aquamarine. The same is true of all the mineral species that include among their varieties the precious stones, the single exception being the diamond; there are no semiprecious diamonds.

Again, a gem stone that today commands a price which places it in the precious stone class, may in ten years dwindle in value to a point where it becomes a semiprecious gem.

Today the precious stones include diamond, ruby, sapphire, emerald, and opal, although, on a basis of value, such gems as alexandrite should be classed as precious. Of these favored few among the gems, both ruby and sapphire are varieties of the same mineral, corundum. In other words, a deep red corundum is a ruby, and a fine, rich, blue corundum is a sapphire.

But here again we come to distinctions

Underwood & Underwood

WASHING DIAMONDS FROM RIVER GRAVEL IN BAHIA, BRAZIL

A wooden bowl, shaped like an old-fashioned chopping bowl, is this Brazilian's only utensil. With a rotary motion he carefully separates clay and silt from the small pebbles, and picks out the diamonds from among the latter

Underwood & Underwood

RUBY MINES NEAR MAGOK, UPPER BURMA

The world's supply of fine rubies comes almost exclusively from this little corner of the Far East "on the road to Mandalay"

and differences. A good judge of gems will tell us that he can distinguish between a Burma and a Siam ruby by the color alone, and that he can note the shade that separates the rare Kashmir sapphire from its less expensive sisters who hail from Ceylon and Montana.

Then there are those usurpers of privilege, the artificial rubies and sapphires, who do not own Dame Nature as their parent at all, and are consequently, on a basis of value, very much semiprecious stones, although they are just as much real rubies and sapphires as those dug from the earth.

The mineral beryl gives us among its gem varieties the emerald, which just now stands supreme among precious stones, and the aquamarine, a sort of poor relation to it, ranking as a semiprecious stone. Here again there are elusive shades of difference in color between the so-called Peruvian emeralds, which really come from Muzo in Colombia, and the Siberian emeralds, some of which constitute the chief glory of the Russian crown jewels.

There are few people who realize how much difference exists between the various shades of color in the aquamarine. This semiprecious gem runs the gamut of color between greenish blue and greenish yellow, as is shown in the magnificent series in the Morgan Gem Collection. Here one may see large choice stones from Siberia, Brazil, Ceylon, and, not least among them, our own United States.

Then there is that rainbow-like gem, the opal, that occupies a somewhat analogous place between the precious and semiprecious stones, sometimes being ranked with one group and sometimes with the other. There are few of us, however, who can resist the charm of the richly colored black opals from Australia, or the harlequin-like fires of those from

Hungary, and despite its evil reputation as a harbinger of ill fortune, the opal will always hold a high place among those of us who appreciate its many-colored beauty.

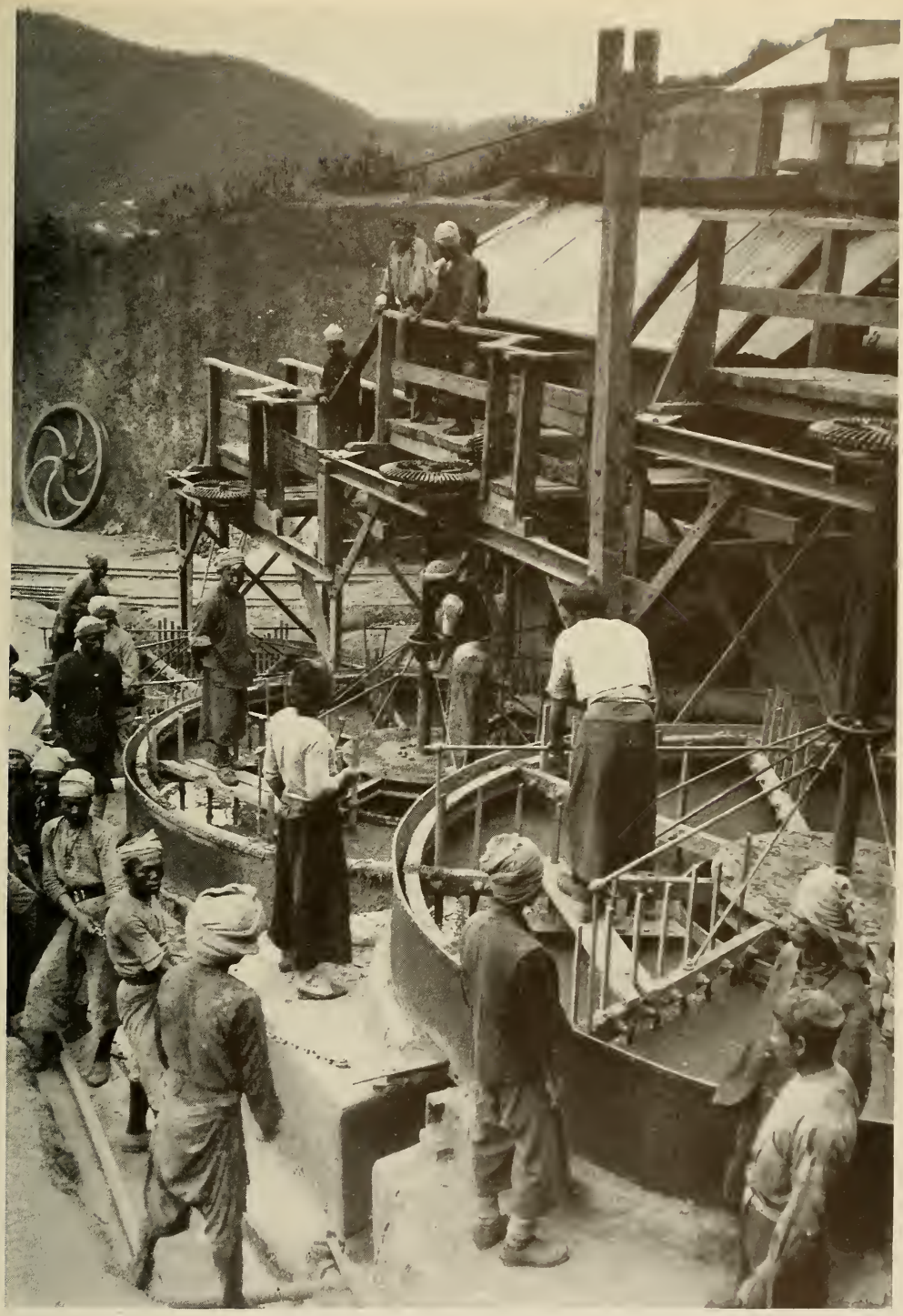
Among the large family of the semiprecious stones, the wearer and admirer of gems may satisfy his (or much more probably her) love of the beautiful, quite apart from the artificial prestige that goes with the possession of something of supreme value. Stripped of the sentiment of expensiveness, a sentiment which actually has its root in barbaric splendor, many of these scraps of frozen color may well rival in beauty the emerald or the sapphire. And how little we know about them! Not one person in fifty knows that there are several kinds of garnets, or that such a gem as the peridot is in existence.

Since the very general custom of wearing strings of beads has been revived among women, I say *revived* advisedly because beads are the oldest and most universal of all jewelry forms, the semiprecious gem stones are coming into a well deserved popularity. People are awakening to the charm of the tawny fire that lives in the heart of the topaz, and to the changeful delicacy of the tourmaline. They are finding out there is a great deal to learn about the semiprecious stones. The average jeweler of thirty years ago was content to know his diamonds, sapphires, rubies, and emeralds, and I have even encountered one in those days who spoke of every stone other than these as a "fancy sapphire." But we have arrived at a time when semiprecious stones are sold in the department stores, and by people who decidedly know what they are dealing in.

Underwood and Underwood

SORTING RUBIES FROM THE RIVER GRAVEL

A handful of pebbles from these river gravels, near Magok, Upper Burma, shows all the colors of the rainbow, and among them there is always the possibility of finding a valuable "pigeon's blood" ruby in the rough. These deposits are known to be of great antiquity, and the sorting of them for rubies and other gem stones has been carried on through many generations



Underwood & Underwood

WASHING PLANT OF THE BURMA RUBY MINING COMPANY

Even in far-away Magok life is not as simple as it formerly was. These mechanical devices for washing the ruby gravel have replaced the primitive methods of bygone years

Underwood & Underwood

PRIMITIVE METHOD OF WASHING THE RUBY-LADEN GRAVEL

Where labor was cheap and manual skill highly developed, the workman was still a major factor, as in these Magok ruby mines, where natives washed and picked over the gem gravel by hand

Copyright by De Cou, from Ewing Galloway

DIAMOND MINING IN SOUTH AFRICA

In this view of the Premier Diamond Mines at Pretoria, we see the bottom of the huge hole representing the excavated portion of the crater or "neck" of an ancient volcano. The rock which completely filled this volcanic vent contains the diamonds. It was from this mine in 1905 that the world's largest diamond "the Cullinan" was taken

The day has gone by when all yellow stones were considered as topazes, and we are also learning to disbelieve the comfortable falacy that all topazes are yellow. The many yellow stones that grace the counters of the up-to-date jeweler have subtle differences in shade which we are beginning to recognize, just as we are awakening to the knowledge of blue and white and orange as well as yellow topazes. It seems safe to prophesy that, as more people gain more knowledge regarding the possibilities of the less well-known semiprecious stones, such as zircon and peridot, alexandrite and kunzite, we shall see these gems come into far more general use.

The objection to the semiprecious stones, which has descended to us from the Victorian period when gems were largely set in rings and bracelets, is that they are for the most part too soft to stand the constant wear to which a piece of jewelry is subjected. Now this certainly does not apply to most of the modern jewelry forms, which from their character would be submitted to very little abrasion, and for which a stone as hard as a garnet would seem to be almost as well fitted as one more resistant to wear.

There is probably no single substance on earth that is so obvious from the point of view of the student of minerals as quartz. It is to be found in all sorts

NATIVES CUTTING RUBIES IN BURMA

In this Burmese lapidary shop progress has substituted for the primitive method seen in the lower picture quite a modern gem-cutting wheel or "lap," operated by foot power. Here the rough ruby pebbles are being covered with angular faces or facets and emerge as "native cut stones"

Underwood & Underwood

CEYLON GEM CUTTER AT WORK

The method of this native gem cutter reduces the implements of his craft to a minimum. The wheel which does the cutting is rotated by a kind of bow-string wrapped around a drum. The stone is held in his left hand

Photograph from The American Gem and Pearl Company

of places, and in all kinds of rocks, from the grain of sand on the beach to the rock formation on the mountain-side. Because quartz is so universally present under such varying conditions, it is not at all strange that we should find in it an almost endless variety of phases. To be sure, as gem stones, these varieties of quartz are not, generally speaking, valuable. They constitute the stones that are priced by the pennyweight rather than by the carat. For this very reason, however, they hold a unique place in the scale of gem values as the materials out of which we may fashion such jewelry as beads, as well as the host of small art objects that are usually decorated with engraving and carving.

There are also, of course, the varieties that are cut into the faceted stones so dear to the hearts of our grandmothers: amethyst, cairngorm, and citrine or false topaz. Generally speaking, however, the quartz gems, or perhaps more properly the quartz stones, are to be found rather in the antique shops and the art auction than in the jewelry store. Some of these are quite the reverse of cheap as, for example, the rock crystal spheres that are so cleverly made by the Japanese, and which now command quite remarkable prices for such a plebeian mineral as quartz.

If you are interested in Oriental art objects, you will find among the things carved out of rock crystal, vases, boxes,

COLOMBIAN EMERALDS IN MATRIX

These emerald crystals from the old mines at Muzo, Colombia, have somtimes been called Peruvian emeralds, because of the veneration with which they were regarded by the pre-Spanish aborigines of that country

and snuff bottles, the work of Chinese lapidary artists. The Imperial Lapidary Works at Ekaterinburg in the eastern Ural Mountains, which, previous to the revolution flourished as a center for the production of Russian carved objects, has turned out some very fine examples of work done in several varieties of quartz. Prominent among these are the rock crystal vases, coupes, and seals, many of these designs being also reproduced in a dark green jasper, characteristic of the Urals.

One may find among the quartz varieties every degree of transparency and almost every shade of color: the satiny sheen of the tiger's eye, and the intricate pattern of the moss agate, the rich purple of the amethyst, and the delicate milky pink of rose quartz.

Few of us are willing to admit that for jewelry purposes a gem stone can be anything but transparent or at least translucent, and yet there are at least two well-known materials of the jeweler's stock in trade that are distinctly opaque, turquoise and lapis lazuli. There are as well a great many less known members of the family of opaque stones that are slowly but surely winning their way into popular esteem, particularly along the lines of modern jewelry. One of the most striking examples of this is, of course, the little group of minerals that go by the name of jade.

It is a strange and very significant fact that all three of the opaque stones we have called to mind have been used for jewelry purposes since extremely ancient times. There are Babylonian cylinders carved from lapis lazuli and engraved with texts that show them to be six thousand years old. There are marvelous inlaid ornaments made of mosaic-like patterns of turquoise that go back to the time when old Egypt was young, and any one who has dipped into the lore of jade will realize how vital a part it has played in the culture of China.

Then there are the stones that we do not know so well, the rich mottled green malachite of Russia, that seems to sound the note of barbaric splendor of the old regime; and its compatriot rhodonite, of an old rose color, that is so much in evidence among any group of Russian carved objects. The apple-green amazon stone also deserves a much more important place among the materials of art jewelry than has been accorded to it.

In this same category we must include the opalescent stones, such as the moonstone which comes from Ceylon, and which seems to bring with it a ray of oriental moonlight. Nearer home we have the labradorite from the Island of St. John off the Labrador coast. This stone seems gray and uninteresting until it catches a glancing ray of light, when it develops the blues and greens of a peacock's feather, varied with fine orange and tawny yellow, a truly surprising performance. Yet I dare say that those of us who have never ventured as far as Labrador have never heard of it.

Of all the varied forms in which gems have been combined in jewelry the necklace is without question the most ancient. From the crude haphazard assemblage of gem pebbles such as primitive man was able to pierce, string together, and hang around his neck, to the most elaborate creations of modern jewelry, we are able to follow in almost unbroken sequence the evolution of the necklace throughout the ages, and in most of the countries of the ancient world.

The oldest civilizations of which we have any knowledge began in their infancy to use gem stones for beads. Earlier than the cuneiform inscribed cylinders of Assyria were the roughly shaped beads that are only now coming to light from recent excavations at Ur. Earlier than the scarabs of Egypt were the charmingly barbaric necklace beads, pendants, and amulets of the first Egyptian dynasty.

Photograph from Ewing Galloway, N. Y.

SAWING ROUGH DIAMONDS IN AMSTERDAM

As one of the first steps in the production of polished diamonds from rough crystals, each of these little circular saws is biting its way through a diamond, charged on the edges with diamond dust, because only diamond can cut diamond. The function of the wheels is to produce, with the smallest amount of waste, pieces of convenient shape to be faceted

And earlier than the quaint engraved Moslem amulets of Persia were the rough lapis lazuli beads whose glory resides in their rich ultramarine color.

The Franks of the Merovingian epoch used agate, jasper, carnelian, and rock crystal beads. These somewhat barbaric necklaces, the heavier of which were probably worn by men, have been recovered from Gallo-Roman graves of the Third and Fourth Centuries, and possess a certain unique beauty and delicacy of color that appeal strongly to our present standards of taste.

Of course, in these, the most elementary of jewelry forms, no attempt at was made setting the stone in metal. The lapidary of that early day was content to drill a hole, not always a very satisfactory one, through his gem-stone bead, string it along with others of its kind, and negotiate it through the current medium of exchange in the manner which is, if possible, older than jewelry itself. But, from a necklace composed of strung beads, it is not a long step to one in which the roughly shaped stones were encased in a gold setting conforming to the irregularities in the shape of the stone, and capable of being strung or suspended from a string as an unset bead would be.

Sometimes a stone which had been shaped, pierced, *and actually used as a bead*, was, at some later stage in its history, set in metal by a worker of a more advanced culture. A good example of this is to be found in the sapphires that adorn the crowns of the Visigoth Kings in the Chuny Museum in Paris. Many of these show the unmistakable shadow of the hole that was drilled through the stone when it was, in an earlier jewelry form, used as a bead. The same is true of the aquamarines that constitute the principal gems of the ceremonial necklace of a Moroccan vizier, in the Morgan Collection of Gems.

If one were to speculate on the history of these gems, an almost boundless field for the imagination is opened up, for it is quite obvious that they have had a history, and in all probability an interesting one.

We know that most of the famous diamonds of the world have had historic careers, involving violence, cupidity, and intrigue. It would be interesting indeed if it were possible for us to write the story of every gem in a jeweler's showcase. Some of them may have been mined only last year, but others may have seen centuries of use as gems. Cut and recut to conform to newer styles in gem cutting, but never losing their identity, they are never destroyed, they never wear out or decay. Even when buried, they are subsequently dug up only to continue their career, inciting future generations to love and hate, greed and murder, as they have incited those of the past.

Gold and silver objects are constantly being melted and shaped into newer forms, but a gem can never lose its individuality. A ruby is always a ruby or an emerald is always an emerald, they can never be anything else.

HOW OUR CHRISTMAS CUSTOMS CAME

The Pagan and Christian Sources from which Have Sprung the Numerous Practices that Make Up Modern Christmas

By FRIDA DAVIDSON

MODERN Christmas has its two aspects of the merry season and of the holy time fairly well blended, for the second gives sanction to the first, even though the first overshadowds the second in actual life. The Infant Saviour is the accredited cause and origin of the festival as it was built around him by the Church and hallowed by tradition and age-long faith; but modern usage plus commercial enterprise have pushed the more robust figure of Santa Claus well into the foreground. He sets the pace for us and we follow his merry, though sometimes breathless, lead with a vague feeling that there is, after all, some connection with the birth two thousand years ago of the Holy Infant in Bethlehem.

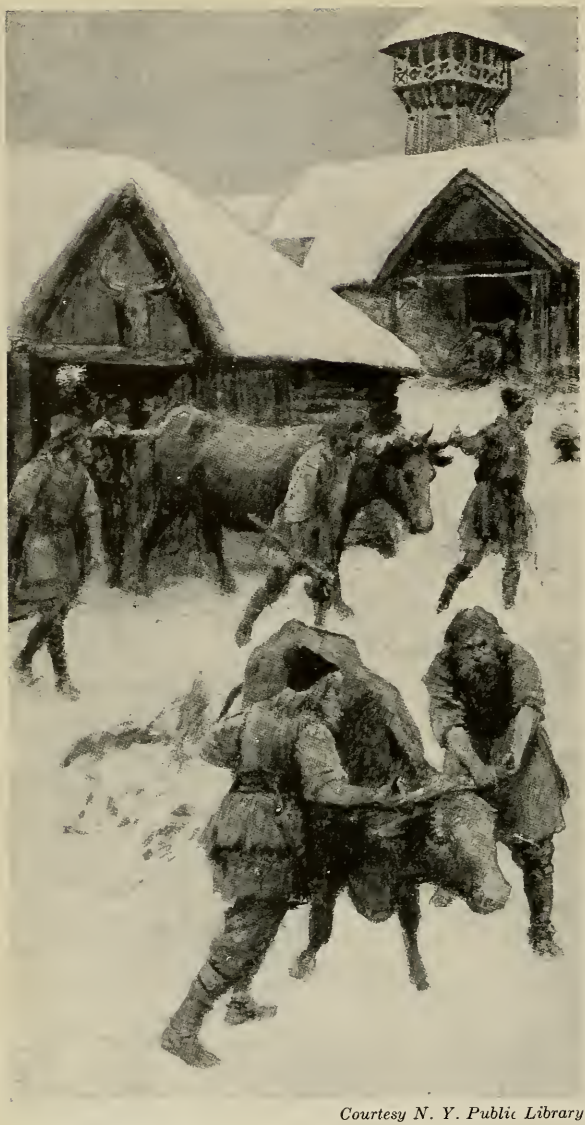
Courtesy N. Y. Public Library

DECORATING A ROMAN VILLA IN LONDON, FIFTH CENTURY

Sacramental cults in connection with the plant world originated in pre-Christian times. Adorning houses with evergreens at the January Kalends or New Year's Day was a common practice in the Roman Empire

Because the beauty and sentiment of the Nativity story form its greatest value, it figures not at all at this point that the date of Jesus' birth has never been determined with accuracy. Indeed, it has been attributed at various times to every month in the year according to the source of information considered. The Gospels, of course, give no date. Ancient Oriental records list a notice that is only historic in intention and separate from the Church calendar, of the birth of Jesus on December twenty-fifth; but, as the date of his carnal birth, this was not for religious worship. It was rather the manifestation of his glory and divinity that the Church chose to celebrate on January sixth, combining the Nativity, the Epiphany, and the Baptism in one time of worship.

Parallel to this ecclesiastical Christian holy-day, the existence of pagan folk-festivals, such as the Yule and the Druid rites, has been generally recognized. The ancient Bede mentions a pre-Christian festival of the people of Anglia on December 25, called "Modranecht," mother's night. Few observers of Christmas, however, are aware of the significant relation to it of the sun in its phase of the winter solstice. We remember primitive man and his growing fear when the days became shorter and the cold increased; how he appealed with prayer, and burned sacrificial fires to appease the angered sun god. The sun paused in his path as if to listen; then no doubt pleased by the attentions, was prevailed upon to return and lengthen his daily stay. Great rejoicings, and



Courtesy N. Y. Public Library

SAXONS LEADING OXEN TO SLAUGHTER, FIFTH CENTURY

The custom of slaughtering animals for the midwinter solstice festival probably had a sacrificial or sacramental origin. "Yule Doughs," the little images made of paste, presented by bakers to their customers at this season, may, when in human or animal form, have taken the place of actual sacrificial victims

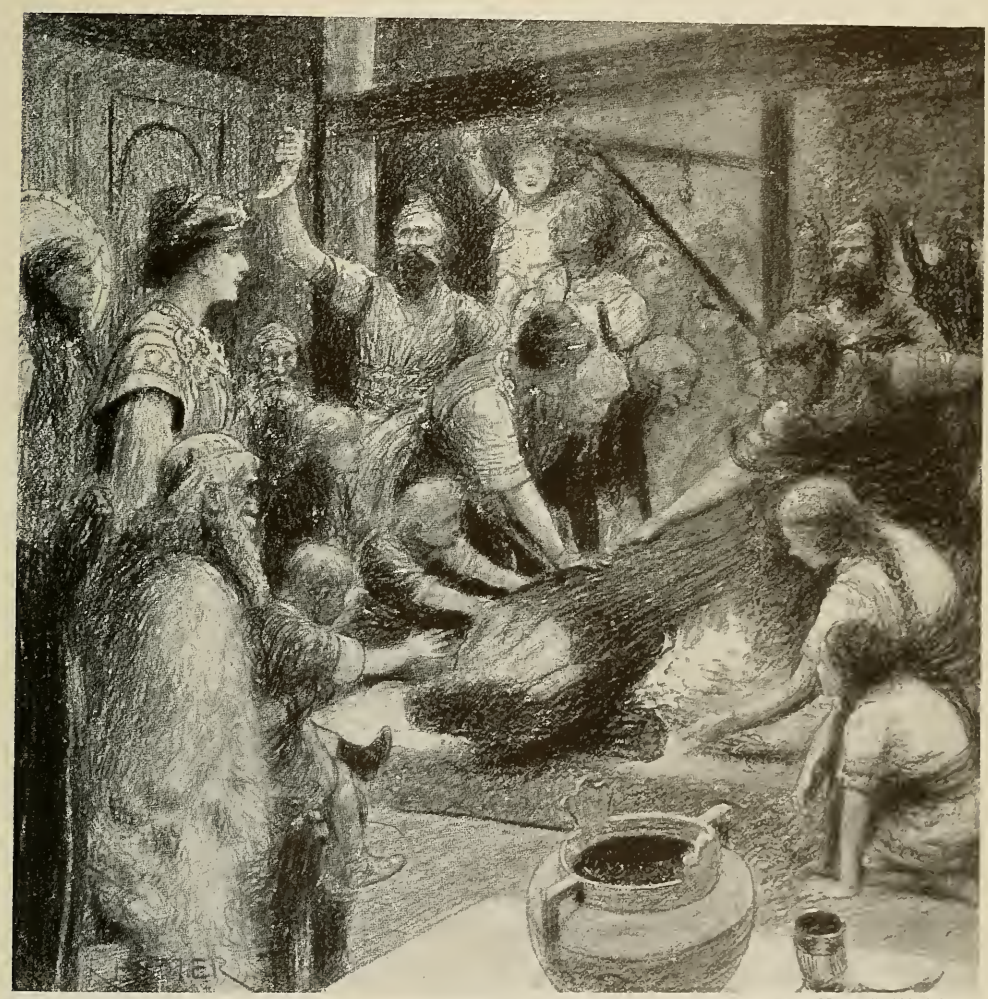
more fires. Those altar-fires are connected in unbroken sequence with our Twentieth Century Christmas, one might almost say that our Christmas-tree candles were lighted at their blaze. Everywhere the universal act of worship on every altar, in every age,—mystic, symbolic, æsthetic, accessible—has been the sacred flame, the fire that could reach its smoky fingers to the God above, the light that repeated in small compass the image of His greatness, for it is the sun, the great benefactor of primitive man, who was to him the supreme power, and who is the radiating source of all early religions. With that key and *Leitmotiv,* practically all mythologies may be disentangled.

It would take us far afield to trace the variety of religious observances for the winter solstice the world over. By the time Rome was old enough to make herself heard, this winter festival had been long established. Already there was an accretion of inherited customs of minor celebrations of the winter season. From the Greek Dionysiac festival of harvest rejoicing came the wild orgies of drunken feasts, pig-sacrifices, and animal-maskings. As an imitation of the Golden Age of Saturn, temporary equality between masters and slaves reigned during its term, December 14 to 27. There were gifts and noisy processions, and suspension of all labor "save cooking and baking." During this same period various forms of Syrian and Persian sun-worship were persisting within the Roman Empire, culminating in the order issued by the Emperor Aurelian (about 275 A.D.) to designate December 25 for the great festival of the "Dies Natali Invictus," or "Birthday of the Unconquerable Sun." The same date was the Nativity feast also of Mithra, the

Persian sun-king, whose lessons of purity and immortality long made him a rival of Jesus to the serious-minded of those early centuries.

Thus influences converged from many pagan sources to single out December 25 as the approved day of religious worship throughout the Roman Empire and farther. Continued observance rooted it deeply in the lives of the people. Just where and how did these pagan and Christian elements finally meet?

The next step in that story is the most important of all Roman feast days—the Kalends or the New Year's Day, which followed close on the heels of the Saturnalia, gradually taking to itself in exaggerated form all the riotous customs of the earlier festival. On this day the Senators took office with prolonged festivities and banqueting. A special feature was made of the decoration of the doorways with green branches, and the lighting of many fires and tapers. Money



Courtesy N. Y. Public Library

THE YULE LOG IN A DANISH VIKING'S HALL, EIGHTH CENTURY

Some writers believe the Yule Log is an embodiment of the "vegetation spirit," and its burning is a symbol of sunshine, to secure the beneficent influence of the sun during the coming year. Others interpret its burning as a solemn annual rekindling of the sacred hearth fire,—the center of family life and the dwelling place of ancestral spirits

was spent lavishly and presents of fruit and flowers sent to friends and officials. The Emperor Caligula, indeed, commanded them from his Senators, and vulgarly stood in his porch to receive them. Perhaps referring to the goddess Strenia (meaning fertility), these gifts were called strenæ, a word which has survived in the French *Étrennes* or New Year's Gifts.

Meanwhile, the Christian fathers, turning their back on heathen Kalends, celebrated the Feast of Epiphany on January sixth with prayerful gloom and fasting. They were distressed to find it difficult, almost impossible, to summon their flock to attention and solemn worship so soon after the high old time of the Kalends. Exhortations to reform found meager response, and prohibitions against pagan customs produced scant returns in piety. And then a Daniel came to judgment: some wise head hit on the idea of compromise by separating the celebration of the Nativity from that of the Feast of Epiphany, and dedicating to its special observance the twenty-fifth of December, —the listed date of Jesus' birth, the day already fixed in the popular mind as a religious-nativity feast! The people were urged to transfer their devotions "from the sun, and to Him who was the Sun of Righteousness."

Behind the pagan altar and the accustomed gaiety of the Roman Kalends the astute fathers had slipped the frame of ecclesiastical sanction! With the help of such men as St. Augustine and Pope Gregory, the two elements became slowly fused, and as the traditions for worship on that December date brought the flock to the Christian altars, the Nativity of Jesus Christ was permanently attached as a religious festival to December 25. An old manuscript, called the Philocalian calendar, places the first Nativity

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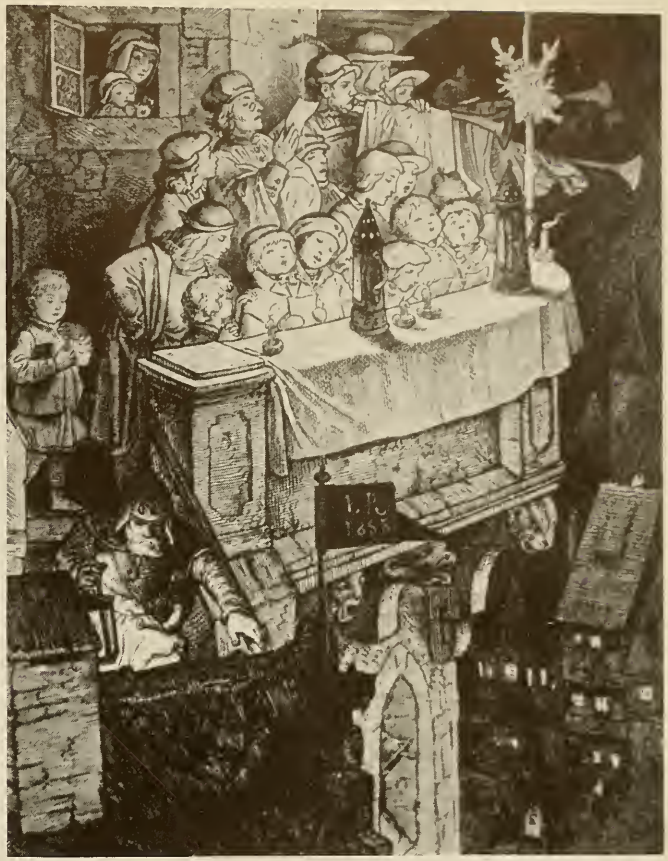
KING OLAF'S CHRISTMAS

"Thor's hammer or Christ's cross: choose!"—So did King Olaf call upon his wild warriors who championed the heathen age, to give up the sword and dedicate Norway to Christianity

festival in the middle of the fourth century. But once this date was accepted, the Church's efforts to eradicate all pagan observances and reminders were pursued with energy, later with vehemence. The green decorations and the fires were especially denounced as signs of wickedness. "Let the heathen kindle lamps" — writes Tertullian, "they who have no light. Let them fix to the door-posts laurel branches to be burnt . . . . . But thou, O Christian, art a light to the world, a tree that is ever green. Make not a pagan temple of thy own house-door."

The practice of animal-masking and mummers, accompanied usually by extravagant actions and indecencies, was even more violently denounced. Most primitive religions used animal dress and masks in their processional rituals, because it was believed that by assuming the outward form of the sacrificial animal,—the skin as a garment, the horns as headdress, and so on,—its sanctity, its desirable power, would be transferred to the worshiper, and the mystic contact, a chief function of sacrifice, thereby achieved. Not until in 729, when Pope Zacharius forbade the Kalends forms of celebration by strictest injunctions and added them to penitential offenses, could the revelers be restrained. However, after these many centuries, they may all be found revived, in modified form, attached to the modern Christmas.



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CHILDREN SINGING CHRISTMAS HYMNS

In some German towns the old custom of singing Christmas hymns from church towers is still continued. One of these songs is "Von Himmel Hoch," written by Martin Luther, after the Reformation, especially for his little son, Hans

Asceticism and prayer dominated the medieval Nativity festival until a feeling for freer expression brought from the lowly peoples of Europe the Miracle Plays, the Noëls, Carols, and *Weihnachtslieder*, which are a mine of beauty in themselves well worth exploring. Exquisite loveliness and tender affection combine with crude naturalism and peasant humor in the naïve telling of the story of the Holy Birth. The presipio, crèche, or crib was the plastic rendering of the same theme in similar mood. St. Francis of Assisi is reputed to have originated it (not authenticated). However, he is known to have

Courtesy N. Y. Public Library

ENGLISH MUMMERS

The wearing of animal masks by mummers at Christmastime apparently is a survival of the old pagan festival rite of wearing the hide, head, or horns of a sacrificial animal, so that the divine life or sanctity of the victim may be transferred to the worshiper

used it in a Christmas service at Greccio in 1224. Later, this charming institution spread through all parts of Europe and may still be found in the congenial atmosphere of the Catholic churches. An ancient "Feast of Lights" entirely unrelated to Christmas except for its nearness in date, is the Jewish "Hanukkah," in commemoration of the Maccabean victory when the candles could be relighted on the altar of the restored temple of Jerusalem.

Another side of our cultural heritage, the still older Scandinavian mythology, contributes the sheaf of the Yule-log traditions, dating from the legend of Yggdrasill, the Tree of Life, and forms of tree-worship common to the druids and other rude religions. This was often a feast for departed spirits as well as a protection against evil powers and a charm to assure fertility or good luck. The Yule season emphasized the good things of life and the sharing of them with the less fortunate. It was an aristocratic festival, for the log-fire was only for the hearth of the wealthy; others contented themselves with a bundle of faggots or a few sticks. But always and in every locality, there was some formal ritual that attended the bringing-in and the lighting of the log on the hearth. Oak, holly, ivy, and mistletoe had each its own place in the feast-time; the evergreen, perhaps because of its connotation of immortality, was finally chosen as the most important.

But the Christmas-tree, as we know it, came to us from German soil and is a truly democratic and domestic institution. An unfounded story suggests that Luther started the custom for his children to repeat the beauty of the starry heavens; actually the origin is not known. German writers mention it as early as 1605, and by 1737 it had already become the real *Weihnachtsbaum*. Useful presents had no place on it, it was all glitter and candles, tinsel, wonderful stuff unrelated to everyday life. The symbolism of the figures of

Courtesy N. Y. Public Library

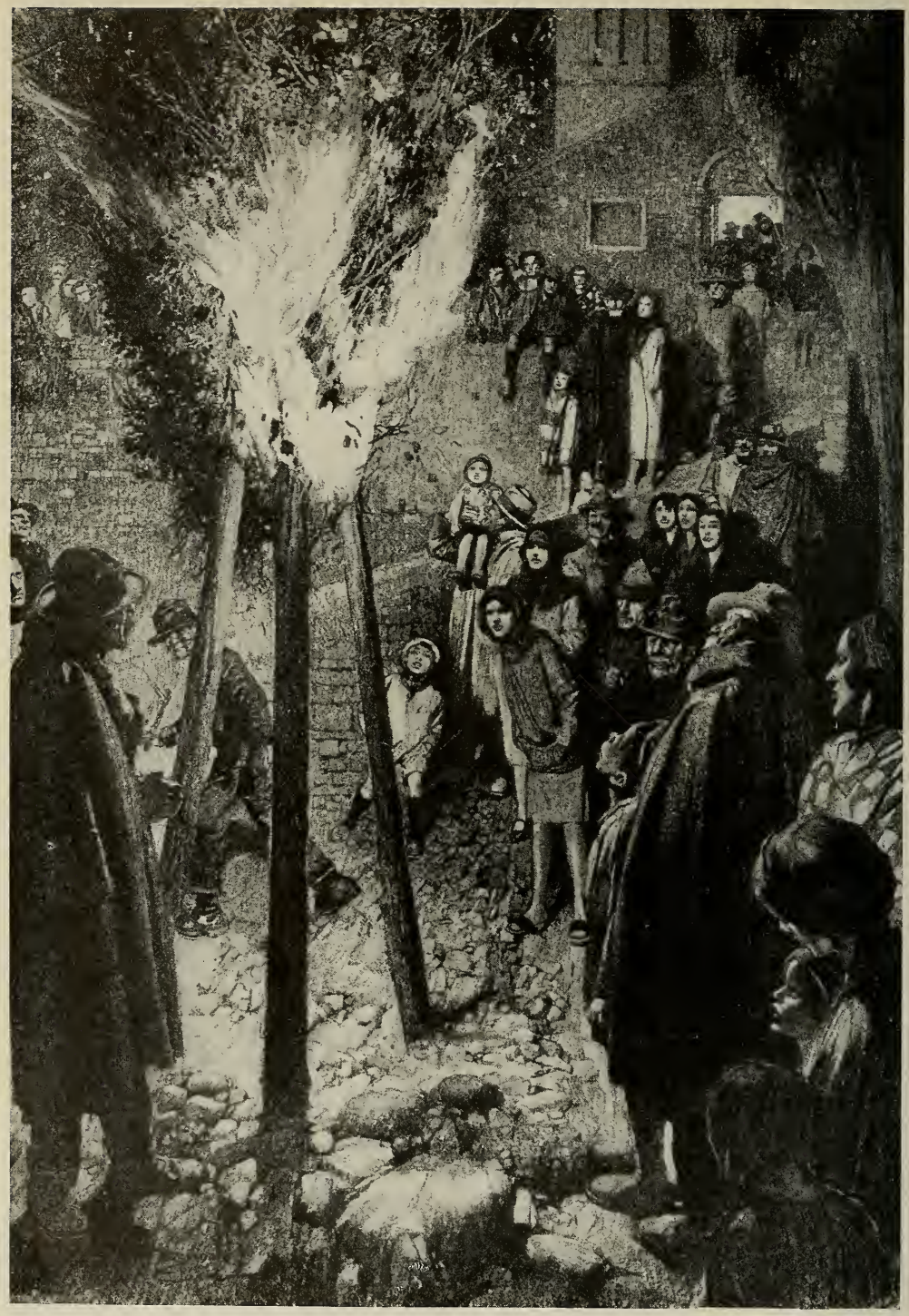
A NATIVITY CRADLE IN TYROL

Plastic representations of the Nativity at Bethlehem are the special delight of children at Christmas-time. St. Francis, it is said, in 1224 used a real ox and ass, in a Bethlehem scene

Courtesy N. Y. Public Library

THE CRÈCHE IN A CHRISTMAS PROCESSION IN FRANCE

"The village children, armed with tapers . . . carry about the streets . . . a little crèche, singing as they go"



Courtesy N. Y. Public Library

A CHRISTMAS MORNING CUSTOM AT LAKE COMO

Burning a "tree" of evergreens and flowers, to which all the congregation contributes

dolls and animals, gilded nuts and fruits, always hung on the tree, harks back to the Kalends and older festivals. From the richest to the poorest, every home hoped to show the lighted tree to welcome in Holy Night. It was decked in great secrecy by the elders, then the whole household, including the servants, gathered around its aromatic, bedecked branches to sing the *Lieder* to the *Kristkindel* (Christ-child). There is an element of naiveté in the German folk attitude to God,—*der liebe Gott* is an approachable, lovable, personality,—which makes possible also the inclusion of the appearance of the *Kristkindel* under the humble roofs on Christmas Eve. His companions went under many names and had many attributes, but the most constant was *der heilige Sankt Nikolaus*. He was called *Sankt Klaus* in Holland and no doubt emigrated with the Dutch settlers to this country to become Santa Claus in the American lingo. The original St. Nicholas was a bishop of Myra in Asia Minor in the Fourth Century. Legend tells of his miracle in restoring to life two murdered boys (in spite of their having been chopped up and pickled in brine by a villainous inn-keeper), and of his many kindnesses to children, which accounts for his having become for all time the children's saint.

It was long before England accepted the Christmas-tree. The Puritan regime suppressed anything that hinted at "Romish" custom, so the candles and tapers were taboo. But, directly or indirectly, through German influence it crept into the homes, to be ultimately introduced into good society by Queen Victoria and her German Prince Consort.

Because of their beauty, two minor Christmas legends should not be ignored: of the miraculous power of Christmas Eve that brings blossoms to the buckthorn and other forest-trees at midnight, and that makes the lowly cattle kneel in their stalls, and lift their voices in exultant reminiscence of the holy time when their ox and ass forbears with their warm breath brought comfort to the Infant Saviour in the manger, and bore witness to the glories of the Nativity night.

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ST. NICHOLAS AND PIET, HIS BLACK SERVANT

In Holland a man acting as St. Nicholas, the patron saint of the children, rides through the streets on St. Nicholas Eve, December 6, promising rewards to those who have been good

SAMOAN CHILDREN AT WORK AND PLAY

Childhood and Youth. A Tropical and Idyllic Land to Which the Modern Psychological Problems of Civilized Youth Have Failed to Penetrate

By MARGARET MEAD
Assistant Curator of Ethnology, American Museum

WHEN anthropologists make trips to the far corners of the earth and search out the primitive peoples who live there, they do not go only in search of spears and bows, moccasins and snowshoes, tortoise shell rings and shell bracelets. Neither is their interest confined to measuring the height of the heads and the width of the natives' noses. Nor are they contented when they have dug among the ruins of earlier villages and extracted ancient, forgotten forms of stone weapons from shell heaps and ruined fireplaces. But they study also the lives of the people, birth ceremonies and burial customs, marrying and giving in marriage, all the quaint and curious ways in which these isolated groups of human beings have made a pattern within which to live their lives. These studies add to our knowledge of the different ways of life under which human existence is possible, of the different kinds of demands which human beings can meet bravely and well.

It was to add to our store of this kind of information that I went to Taū, a little island in American Samoa, and spent nine months living among the few hundred South Sea Islanders who inhabit it. As a Fellow of the National Research Council I went there to make a study of Samoan children and Samoan girlhood, to find out if the pains and pangs of growing up were as difficult in Samoa as in America.

This was no problem which could be solved in a flying trip. I could not just walk into the round, unwalled houses, with their high thatched roofs and pebbly floors, sit down on the mat which is always spread for strangers, and say to the guest-house mother who sat nursing one baby while a little older child tangled her half-finished mat, "Well, now, tell me, what are your children's names? How old are they? And Flower is the oldest? Does she take her responsibility seriously? Is she good and obedient? Is she bossy with the other children? Was she jealous when the new baby came?"—and then pass on to the next mother and ask her the same kind of questions, putting the answers all down on cards, to be counted and written up after I got back. If that mother, in her soft Polynesian language in which her children and I made the same mistakes, had answered my questions directly, I should not have understood her answer. For they would have run something like this:

"Names,—well, the baby's name is Pandanus Nut, that's what we call it, or just Nut for short. But its name from its father's father's family is 'The One that Does Not Move,' and only yesterday my younger brother gave it his name of 'Lighted House,' so perhaps we will call it that now. And how old is he? Well, he was born after the second Palolo Fish Feast, and before my young cousin, Hibiscus, had her baby girl. He can't walk yet. The next one to the baby is called Bonito Fish. He is a boy. I don't know how old he is. And Flower, she is a girl, is the oldest of my children who are at home. There is that one, a boy, his name is White Stone, who lives with my

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IN THE SHADE OF SAMOAN COCONUT PALMS

Samoan children have no recognized group activities, nor do they take any part in the social life, except that of formal dancing

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THE MORNING DIP

Childhood's universal objection to the bath appears to be lacking in these small Samoans. Young babies are frequently bathed with the juice of a wild orange and rubbed with coconut oil

Photograph by Mrs. William Churchill

A CLUSTER OF SAMOAN HOUSES

The Samoans still live in open-sided conical-roofed houses, the only walls of which are the woven mats, lowered in inclement weather

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A SAMOAN FAMILY GROUP

Except for ceremonial occasions, the native bark-cloth clothing has been discarded for a costume made of the more easily obtained cotton cloth

Photograph by Mrs. William Churchill

SAMOAN BOYS

Children under fifteen or sixteen have no social standing in the community

Photograph by Mrs. William Churchill

THE FEAST OF A MALAGA OR FORMAL TRAVELING PARTY

Weddings or guests from a neighboring village are occasions for important festivities

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AT THE PEAK OF THE MIDDAY HEAT

When shade and the siesta are most important to the villagers, the children go off for a swim

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HOUSEHOLD ACTIVITIES AT THE EDGE OF A LAGOON

Metal utensils now replace the coconut shells formerly used for household purposes

THE HEIR APPARENT OF AN IMPORTANT CHIEF
Any of the more powerful rulers has as one of his privileges that of giving the title of *manaia* to his heir

mother, and the girl, her name is Jellyfish, who lives with my first husband's sister in the next village. No, my first husband isn't dead! He's married to the sister of that woman with the banana leaf over her head, who is going down to the sea for water. I don't know what you mean by responsibility. Do you mean she has got common sense in her head enough to know that she mustn't play with her brother nor touch any of his things? She listens easily, not like my brother's children, who listen with difficulty to my brother's commands. Is she bossy? Of course she is bossy to all those in the family who are younger than she is, and listens to the wishes of all those who are older. And which new baby do you mean? My sister's baby, or my younger sister's baby, or my brother's wife's baby? But of course she was glad when all the babies were born."

Only after I had learned to speak the language well, and had spent long mornings sitting gossiping over a coconut or a plate of bananas, after I had learned to plait mats and blinds and helped the harassed homeless people rebuild the village after a devastating hurricane, and had spent even more hours with the little girls themselves, searching for shells, weaving flower necklaces, coaxing land crabs with a low, sweet chant, or swimming in a hole in the reef, did I come to know enough about the Samoan way of life so that I could have understood those answers.

Samoan children's names change often, at the whim of any relative. As soon as they are old enough, they are allowed to choose new ones for themselves upon any occasion. And similarly they choose their own homes, living now with a grandmother, now with an uncle. Families are not made up of father and mother and children, but of some fifteen or twenty relatives among whom there is no oldest child, because a young aunt or cousin will

be nearly of an age, among whom the same child is never "youngest" for many months. And in these great households the mothers take very little care of their children after the babies learn to crawl. The nurses are not young girls but toddling five-year-olds, who trundle about upon their hips babies that are too heavy to be lifted into their arms. Samoan children are not carefully disciplined and supervised until they are five or six, and then, properly trained, given some freedom. They are spoiled and pampered by their baby nurses until they are five, and then, if they are girls, they are turned into nurses themselves; if they are boys, they are turned over to the rough but thorough discipline of older boys. At ten years of age they are sturdy, well-behaved youngsters, although their bringing-up seems so strange to us.

Samoan parents do not hide anything from their children; they tell them no fairy tales about the birth of babies nor do they pack them off to a relative until after a funeral. They believe quite literally that children should be seen but not heard, should be present but make no comments, should learn the important facts of life from careful observation, not from random, groping experimentation. And the children grow up, acquainted with the rhythm of life and death, accepting life as simply and unrebelliously as do their parents.

Nor do Samoan parents think children should not work. The tiniest little staggerer has tasks to perform,—to carry water, to borrow fire brands, to fetch leaves to stuff the pig. And these slighter tasks are laid aside for harder ones as soon as the child becomes strong enough or skilled enough. At the preparation for a feast to celebrate a visiting chief, a marriage, or a new canoe, the little children feel very serious and important, and go scurrying about the village, muttering, "There are

A VILLAGE CEREMONIAL PRINCESS

The girl at the left has been honored with the title of *taupo* and with a distribution of property by a high chief of her village. Her prestige is great as there are but two or three *taupos* in a village

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AFRAID OF THE CAMERA

The small boy in Samoa, until he is eight or nine years old, helps take care of the younger children

Photograph by Ewing Galloway, N. Y.

IN AMERICAN SAMOA

A visit from a neighboring tribe is the occasion for a ceremonious welcome

BEAUTIFUL SAMOA

The harbor at Pago Pago is exceptionally fine. In the foreground is an outrigger canoe

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A DANCING GIRL

The one activity in Samoa in which everyone, regardless of sex or age, participates, is dancing

very great complications in my household." Learning to run errands tactfully is one of the first lessons of childhood, and a child of nine will be trusted to take a valuable piece of bark cloth to barter for a pig.

This attitude toward children as little adults although lacking in experience and sometimes sadly devoid of common sense, makes for a different kind of play also. Samoan children have no dolls, no play houses, no tea sets, no toy boats. For dolls they have real babies; at six they are expected to sweep up the real house and pick all the scraps off the floor. Little boys anxious to become boatmen paddle about in real canoes within the safety of the lagoon. Embryonic eel fishermen hold the bait for their big brothers, but never play-act fishing in a pail, or catch a leaf and pretend it is an eel. Yet they have their games, playing at ball with square light balls made of pandanus, stringing necklaces of flowers, playing round games to merry songs of their own improvising in the dusk. And in all these they but imitate their elders, who follow a morning of work and an afternoon of sleep with an evening of dance and song.

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A SAMOAN BEAUTY

Strangest of all to us is the Samoan opinion of precocious children. To be brighter than your age, to stand out conspicuously above other children, this is the sin for which a child is roundly scolded and sometimes whipped. So it is that the happiest children are those who like to be children, who put off reponsibility, who do what is asked of them without aspiring to more grown-up tasks, those who answer in lazy content, "I am but young."

Photograph by A. M. Bailey

YOUNG WESTERN GREBE

FEATHERED WATER BABIES OF THE PRAIRIES

Birds of the Shallow Ponds of the Dakotas—Grebes and Gulls—Pelicans, Cormorants, and Terns

By ALFRED M. BAILEY
Director of the Chicago Academy of Sciences

THE rolling prairies of the Dakotas, with their vast expanses of grazing grounds, were once the homes of great herds of bison. Antelope occurred in large numbers, and deer were abundant along the wooded bad lands. Today there are few of these mammals, for with the march of civilization it was inevitable that they should disappear.

As with the mammals, so it has been with the bird life. Flocks of wild fowl which "obscured the sun" were not uncommon in the old days, but now only a remnant remains. And yet, even now a visitor to the out-of-the-way lakes cannot help but marvel at the number of birds on all sides.

When the glaciers came from the north, they gouged great basins, and today we find the treeless Dakota prairies studded with a myriad of ponds, sloughs, and lakes, along which our wild fowl build their nests. Many of the lakes are alkali, and but little vegetation grows, so they are of little use to the nesting birds; but others are fresh and support a luxuriant growth of cat-tails, tules, and cane (*Phragmites*). Such a place is Rush Lake in northeastern South Dakota.

Wild ducks of several species,—mallards, blue-winged teal, gadwall, ruddy, pintail, shovellers, and red-heads may be seen daily, and occasionally, when one walks along the grass-grown banks, he is startled by a female duck flushing from beneath his feet. The nesting birds are shy, however, and if given an opportunity, will sneak quietly from their nests.

While securing life history "nature studies" on motion films for the Chicago Academy of Sciences, our party had ample opportunity to study many species of birds at close range. We found nests and erected blinds, and then, when the

Photograph by A. M. Bailey

RUSH LAKE, SOUTH DAKOTA

This shallow pond is similar to many others that dot the prairies from the sandhills of central Nebraska to the Canadian border and beyond

Photograph by F. W. Kubeckek

RING-BILLED GULLS

Far into the interior of the continent the gulls have penetrated, sometimes inhabiting the shores of lakes and ponds far removed from other bodies of water

Photograph by A. M. Bailey

AN ADULT HOLBOELL GREBE

When the young grebes are hatched, they are carried for a time on their parents' backs before they themselves take to the water

Photograph by A. M. Bailey

DOUBLE-CRESTED CORMORANTS

The cormorant is related to the pelican. These birds are powerful swimmers and expert divers, and their hooked bills serve them well when they catch the fish on which they live

Photograph by W. F. Kubeckek

YOUNG AMERICAN COOT

This youngster, occupying a comfortable nest among the reeds, is evidently the first of the brood to break from his shell

parents returned to their nests, they were photographed. It was interesting to note how the different species reacted to the blind, and the reaction of individuals of the same species. Some birds that are ordinarily extremely shy, returned with little fear, while others that are considered tame, would not return at all.

The blue-winged teal is typical of the average species, for after eying the blind from all angles for an hour or so, the little female crawled mouselike through the brown grass, and crept upon her eggs without so much as showing her back above the protecting vegetation. Teal are numerous in the Dakotas, and many thousands nest there annually.

These lakes are particularly favored by the diving birds, and we saw hundreds of nests of the western, Holbœll's eared, and pied-billed grebes. It is possible that the horned grebe nests there also. In our moving-picture work we concentrated on the western, or swan grebe, which is known as the most beautiful of the divers, and on the Holbœll's, which is considered one of the shyest of water fowl. The former nested in the cane and tules of reed-grown ponds, while the latter built bulky nests of moss near the shores of large open lakes.

With the glasses we often could see several birds perched upon their mound-like nests, but when we showed ourselves, the birds quickly covered their eggs with a few deft dabs of the bill, and slid into the water. The western grebes were nesting in such deep water that it was necessary to build a platform to support the blind, and from our narrow perch we could see a dozen of the beautiful fellows cruising among the golden yellow canes, their reflection mirrored in the quiet depths.

An adult would swim behind heavy growths of vegetation to the edge of her

Photograph by Earl G. Wright

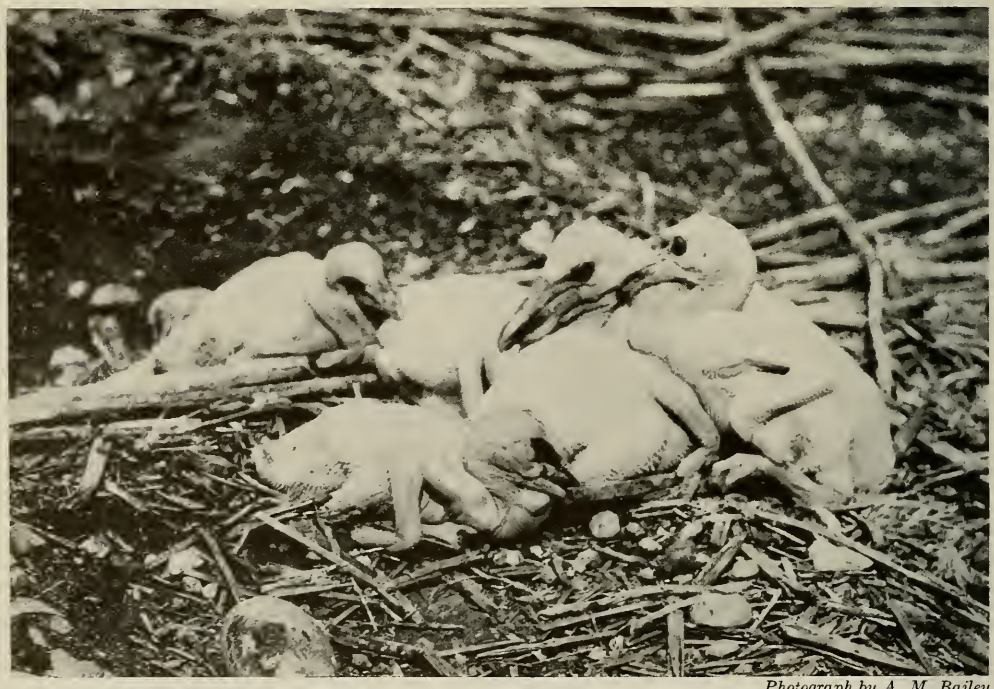
THE NEST OF AN AMERICAN COOT

The average number of eggs in such a nest is from eight to twelve. Sometimes the number drops to six or seven and sometimes it is as high as seventeen or eighteen. On at least one occasion twenty-two eggs were counted in one nest, but it is probable that they were the product of more than one bird

Photograph by Edwin Komarek

BABY PIED-BILLED GREBES

Each of these youngsters, fresh from the shell, still bears the strange little "egg tooth" on the end of his beak. The only purpose of this "tooth" is to make it possible for the little fellow to break the shell. Shortly after the bird is hatched, the "tooth" falls off



Photograph by A. M. Bailey

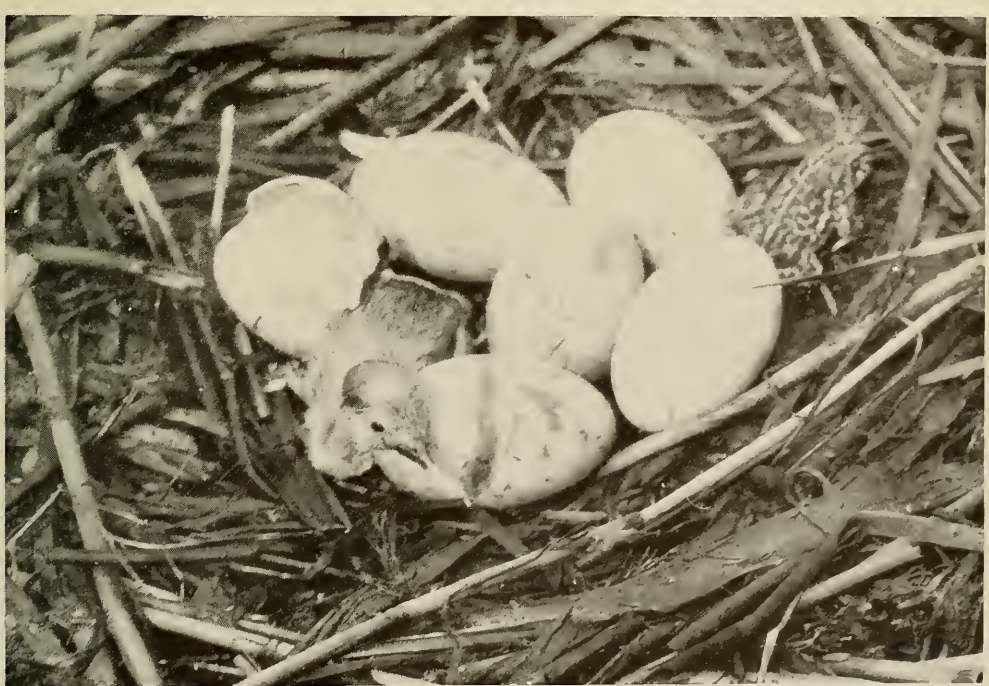
NEWLY HATCHED WHITE PELICANS

These awkward birds are unattractive at this stage because of their nakedness. But even when they have attained a covering of down a few days after emerging from the shell, they still lack beauty

Photograph by A. M. Bailey

A MOTHER WESTERN GREBE ON HER NEST

The western grebes, sometimes called swan grebes, are without doubt among the most aquatic of birds. A cousin of this bird—the grebe of Lake Titicaca, South America—has lost some of its power of flight and is helpless, as well, on land



Photograph by Earl G. Wright

A YOUNG WESTERN GREBE

Unlike his cousin, the pied-billed grebe, this little fellow, just emerged from the shell, is not striped. Note the toad in the nest. This is a common occurrence in the marshes

Photograph by W. F. Kubeckek

RING-BILLED GULLS

The gull is widely supposed to be essentially a salt-water bird. As a matter of fact, gulls of several species are to be found in South Dakota, and many inland lakes support thousands of them

nest, and then remain quietly hour after hour, just eying the blind. Many of these swan grebes had hatched their young, and the downy little fellows would perch upon their parents' backs as the old ones cruised to and fro. Although we saw the adults continually, they were extremely shy, and remained under cover of the swamp growth. The bird we were attempting to photograph would swim to the edge of her nest, where she would "chuck" to the young one in an attempt to coax it away. The youngster became entangled in the grass of the nest and could not reach the parent, so—after hours in the stifling blind, we were rewarded by having this grebe climb upon her home.

The western grebes apparently do not conceal their eggs when they leave the nest,—at least not to the extent that the Holboell's do. This latter species is not so large as the former, nor so strikingly marked, but it nests on open lakes where one can see it at a long distance. We were in our blind many hours before the parents ventured to return to their nest, and then one of them climbed upon the mound and removed the mossy covering, rolled the eggs over with her beak, and settled down upon them without paying the slightest attention to the whirring of the camera. When we clapped our hands, she quickly covered her eggs and slid into the water, and so furnished us with a fitting close to that bit of film.

The Bartramian sandpipers are still found in many of their old haunts, although their numbers have been woefully diminished. We found a nest with three eggs upon a bowlder-strewn bit of prairie, and erected our blind. It was a stormy, blustery day, so the blind thrashed madly in the wind, and the brown grass whipped back and forth. It did not seem possible that this "wader," which inhabits the dry

Photograph by A. M. Bailey

AMERICAN WHITE PELICANS

A close examination of the bird in the center of the foreground will show a small hump about two-thirds of the way down the top of his bill. This decoration is worn during the breeding season, after which it drops off

Photograph by W. F. Kubeckek

DOUBLE-CRESTED CORMORANTS

The birds are quite similar and closely related to the cormorants tamed in China and Japan for use in catching fish

uplands, would return to her eggs, but in fifteen minutes we saw her standing motionless fifty feet away. She disappeared after a few moments, and when we next saw her, she was twenty-five feet away. In less than half an hour she had settled upon her eggs!

Coots are very tame, ordinarily, and yet they seemed very shy about returning to their nests. It took hours in the blind before the *poule d'eau* behaved satisfactorily. Another tame species is the black-crowned night heron. Ordinarily, colony nesting birds are very easily photographed, but, although we left our blind for days, and spent two days in the blind, we did not get a foot of film. We could hear and see young birds being fed all about us, but the youngsters we had under observation were fed at night. A horned owl was living in comfort on that little bird island, for he lived upon the young herons.

In Waubay Lake, a few miles from Rush Lake, is a little rocky islet known to the people of the vicinity as Bird Island. It is appropriately named for there was a colony of five hundred double-crested cormorants, and about three hundred of the common terns, and an equal number of ring-billed gulls. These birds were typical of many of the island colony nesting species, for they readily returned to their nests, and were little alarmed when the camera was turned upon them. The cormorants were well advanced in their nesting, and the hundreds of bulky platforms contained from three to four downy black fellows with long necks and reptile-like heads. They keep their heads bobbing, and they make a strange noise, the combined noises sounding like the faint roaring of the wind. The beautiful gulls and terns were very tame, the former quickly returning to the large downy young hidden in the grass, while the terns settled upon their three dark-colored eggs.

Photograph by W. F. Kubeckek

THE COMMON TERN

These little birds are widely distributed in Europe, Asia, Africa, and America

One could write of many species which occur commonly, the beautiful Wilson's phalarope, Hudsonian godwit, western willet, killdeer, spotted sandpiper, Franklin's gull, and the black tern. One can hear the booming of the prairie hen and the querulous cry of the Forster tern, while during migration time, great hordes of blue, snow, and Canada geese honk their way through to their northern nesting grounds.

The ponds and swamps of North Dakota support a bird life which is as interesting as those of South Dakota, and on one of them, Chase Lake, in the south central portion of the state, we visited a large colony of white pelicans. There were about eight hundred of them nesting upon a large island in the middle of this alkali lake, which has been made a Federal Bird Reservation, and as they have been carefully protected, they were extremely tame. Anyone but a bird photographer could wax poetic about these beautiful white birds with their black pinions, as they sail on motionless wing against a dark storm-whipped sky, or as they settle to their nests, where their ugly youngsters are waiting with wide-open beaks, but he must fight sunlight and shadow and drizzling rain to see that his exposures are uniform. Weeks later, when the film is assembled, he begins to appreciate the beauties of stormy, billowy, Dakota skies, and the marvels of the bird life that still abounds.

SKETCH MODEL OF INDIAN BUFFALO GROUP

THE JUNGLE LAND OF BURMA

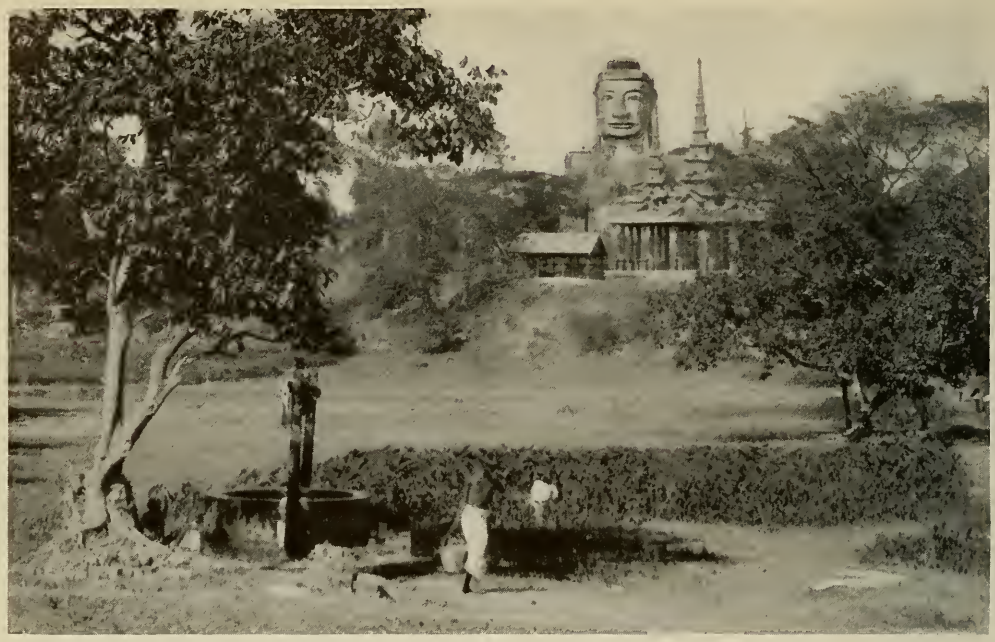
How a Museum Expedition Collects the Information and Material for the Foregrounds and Backgrounds of the Great Habitat Groups

By ALBERT E. BUTLER
Department of Preparation, American Museum

Mr. Albert E. Butler, the author of this article, was sent during 1928 to India, Burma, East Africa, and Angola, in order to obtain the material and the data with which to construct the backgrounds for several animal groups collected by Mr. Arthur S. Vernay and Col. J. C. Faunthorpe for the American Museum of Natural History. In the following article, Mr. Butler tells of some of his experiences and his work in Burma, where he—in company with Mr. C. C. Rosenkranz—went to obtain the backgrounds for the Tsine buffalo group, the Thamin deer group, and the Sumatrensis rhinoceros group, the animal specimens for which had already been collected. The expedition first visited northern India, and on completing its work in the shadow of the Himalaya, moved its scene of activities to Burma.—The Editors.

COMING from the cold of North India, near the Himalayas, on the border of Nepal, to the warmth of southern Burma, in itself is a pleasant experience. I had long looked forward to that part of my trip, but when we arrived in the harbor of Rangoon, it was not without a certain feeling of disappointment that I looked upon much the same type of harbor city that I had seen in India. Modern buildings, wide paved streets, and many automobiles, most of them of American make, gave a distinct western air to this far eastern city. The one varying note in the picture from the harbor is the gold of the frequent spires of the pagodas which glisten dazzlingly in the bright tropical sunlight. One's impressions gradually shift as one sees more of the city and realizes that its population is mainly Burmese, and that these smiling people still cling to their native customs and dress, a rare few showing any influence of western civilization in their personality.

The native *poongyis*, in their yellow robes, are amazingly numerous and apparently well taken care of by these simple people of whose religion the *poongyis* are revered priests. Temples of wor-



ON THE OUTSKIRTS OF RANGOON

These huge statues of Buddha are occasionally to be found dominating the Burmese landscapes. More often, however, the statues are far smaller and housed in the numerous temples and shrines

ship, the pagodas, are numerous, quite imposing, and usually house gigantic and grotesque idols. The immensity of these figures is felt only when one is seen occasionally in the open landscape. Then they appear like huge ogres threatening everything in sight.

The more common means of conveyance, the rickshaw, is seen everywhere, and much of the trucking is done by heavy two-wheeled carts which are pulled and pushed by natives, usually several to a cart—varying with the load.

Further inland the towns are almost entirely native, with but a handful of English government officials. Such a place is Tuangdwyngyii, 250 miles north of Rangoon — a town of about three thousand Burmese and a dozen English.

To this native city we made our way enthusiastically, keen for our first glimpse of the interior of Burma. Our work called for the gathering of those innumerable specimens of the flora and geology of the country that were required in order to complete at the American Museum the foreground and background of the group of *Thamin* deer, which had already been collected by Colonel Faunthorpe, as well as similar material for the group of *Tsine* buffalo which was to appear finally in a setting of bamboo forest.

Probably there is no wide understanding of the great amount of detail required for the proper completion of such a museum "group," for quite naturally the animals dominate the completed exhibit and often the work of the preparators in completing the details of foreground and background fail to impress the observer proportionately.

Each group presents a different problem and the differences are often radical. Each setting must be typical of the country in which the animal is found, and in order to collect specimens of soil, rocks, grasses, and leaves, it is essential that studies be made of exactly the proper

surroundings. It is the business of the preparator to select a site that will make possible the collection of those materials that he will require, and, of course, careful studies must be made by the artist in order that the setting may be not only typical but also, in so far as possible, artistic. With these points in mind, the preparator and artist who enter the field—in the case of the Burmese trip, Mr. C. C. Rosenkranz was the artist and I the preparator—agree as to the vicinity to be reproduced in the group. As soon as this is done, the artist goes about his work of making landscape paintings and studies of trees, flowers, and so on, while the preparator proceeds to collect such material as is typical of the region and suitable for reproduction in wax, celluloid, and other media of his art. Occasionally large quantities are needed.

Any grasses required, for instance, are collected and packed carefully so as not to become broken in shipment, for such material can be preserved, recolored, and actually utilized in the group. Leaves and twigs of the plants selected are carefully packed in tanks containing a formalin solution—tanks for this purpose having been specially made and included in the field outfit. Plaster molds in series are made from leaves of each plant form, and similar molds are made from flowers in much the same manner. Color sketches are also made in order that the artificial reproductions may closely immitate nature, and if time permits, wax reproductions are sometimes made on the spot and colored in imitation of the freshly growing plants. Samples of rocks and sections of tree bark usually are all that is necessary of such material, for these can be faithfully imitated in the work shops of the Museum where paper maché and plaster take their place. Surface earth, twigs, and leaves are usually collected in sufficient quanti-

PREPARATIONS FOR A RELIGIOUS FESTIVAL
These structures—both the "temple" and the float—are constructed entirely of bamboo and paper. They are highly decorated in gilt and color, and are burned at the conclusion of the festival

A STUDY FOR THE BACKGROUND OF THE TSINE BUFFALO GROUP
This painting, by C. C. Rosenkranz, was made in the bamboo forest near Kokkogon, about 200 miles north of Rangoon

IN THE DEPTH OF THE BURMESE JUNGLE
A photographic study for the background of the *Sumatrensis* rhinoceros group, made near Taikkyi, about fifty miles north of Rangoon

A NATIVE BURMESE BULLOCK CART

These crude two-wheeled contrivances are the only transport for heavy materials in the native towns of the interior of Burma

A BAZAAR AT TAIKKYI

Usually each town holds a bazaar once a week. Practically all of the native bartering is carried on at these gatherings

ties to cover the surface of the space devoted to the group, and finally, innumerable photographs are made of every element that enters into the building of the group.

When one realizes that it is the task of the preparator and artist to gather the fragile materials for making and building a group, and to make accurate color sketches and molds of every type of leaf, twig, blade of grass, and stone within a space of, say twenty feet square, in the jungle, besides painting a view from the spot that has been chosen, it is a little easier to realize the amount of detail work that is required.

Naturally many unexpected obstacles arise, and we had no sooner reached Taungdwyngyii than an insurmountable one faced us, for we had not been informed that a festival commemorating the anniversary of the death of a local saint priest was scheduled for the next week, and that the entire population was planning to take the week off in celebration. We managed with no little difficulty to get transportation to the *Thamin* district, which was near by, and completed the work there. Fortunately, the site we chose for this work was not far from town, for we soon found that no inducement we could offer would influence any native to desert the coming festival celebration for as much as a full day.

Finding it impossible to move to our next site, we attended the festivities on two evenings while in Taungdwyngyii. For this we had no trouble finding an escort. Furthermore, the celebration was entertaining and amusing, though the ceremonies were not within our understanding. Many structures built of split bamboo, of dainty design and color, had been erected for the occasion, only to be burned when the festival was completed. In half a dozen of these places dances and plays were given upon improvised bamboo stages, and the entertainments were carried on far into the night. We did not remain to see whether the actors or the

MR. BUTLER WORKING ON A SCALE MODEL
This model is of the *Sumatrensis* rhinoceros group, which ultimately will be erected life-size

A PART OF THE EXPEDITION IN THE FIELD
Mr. Rosenkranz is seated in the center of the group with Mr. Prater of the Bombay Museum, together with several guides and carriers, at a rest house on the way to camp near Taikkyi

audience tired first, but I concluded that the play could end for no less a reason, since all I saw in several hours seemed to be a constant repetition of the first few minutes. The plays must have been comical, however, for the audience laughed frequently at the chanting chatter. We couldn't appreciate the jokes that appealed to them, but we did occasionally get a laugh when an actor stopped in the middle of his line and spat under the stage bamboo rug, or a dancing girl stopped her act to scratch her leg. These incidents seemed not at all amusing to the audience, however, and our laughter, no doubt, seemed to them to be both ill-timed and ill-bred.

An interpreter told us that the body of a certain deceased priest had been preserved in honey, and that at the end of the festival this preservative was eaten by as many as were fortunate enough to get a share of it. However this may be, I abstained from eating any native honey while in Taungdwyngyii.

It was impossible for us to see the festival through to its end, for our plans could not be made to fit the occasion. Consequently, after three days we moved to Kokkogen, twenty miles farther south, near which, we were told, was heavy bamboo forest. Furthermore, we were told that at this new town we would be able to obtain the necessary help to carry on our work. The forest we chose was mainly composed of tall, small-leafed bamboo mixed with teak and other trees of large-leaf varieties. The delicate masses of bamboo leaves resembled vast collections of green feathers, forming an odd contrast to the huge teak and other leaves, many of which measured fourteen inches wide by thirty inches long.

All through this region we found the bombax and "flame of the forest" trees in bloom. The leaves do not appear until the blooming period is over, and the glow of these densely red-flowered branches in the sun is an amazing spec-

THE EXPEDITION HEADQUARTERS AT TAIKKYI

These forest bungalows are erected by the British authorities, and by arrangement with the governmental officials the expedition made use of them. In this particular house several natives were murdered shortly before the arrival of the expedition, much to the discomfort of the expedition's carriers

tacle. The bombax flowers, which last about three weeks, contain a nectar that is intoxicating, and the birds flock to these trees at first sign of dawn and leave reluctantly at dusk, screaming, quarreling all day long, their excited chatter resembling a drunken brawl.

The bamboo forest in which we worked was filled with bird life. Wild peacocks and jungle fowl being common and easily secured, we relied upon these mostly for meat in camp. We sketched and photographed and gathered specimens in the midst of a veritable aviary.

It was our misfortune, however, to be working on schedule and when, after four days, we completed the work of securing material for our *Tsine* group, we broke camp in the early morning and trekked six miles back to Kokkogen. We rested in the town until train time, sitting meanwhile on the verandah of a little hut owned by a Mohammedan merchant, who permitted us to have our lunch there, sheltered from the intense heat of midday. We noticed that he observed us closely during lunch, and we hastened to assure him we were eating no pork under his roof. This would have been a mark of great disrespect.

While our host's old father lay sleeping on a bench near by, his pretty wife, a Burmese girl, attended her tiny baby and part of her husband's store at the same time. The dogs, cats, and chickens, of which there were many, wandered on to the porch and through the house whenever they were unwatched. The poor creatures seemed so hungry that they were willing to brave a kick for a morsel of food, but in the absence of something to eat they seemed always ready to bolt at the movement of a human hand or foot.

Our return to Rangoon was necessary before proceeding to Insien to collect the materials for one remaining group, the *Sumatrensis* rhinoceros. Our original plans had called for just the reverse of the schedule we found ourselves following. Because of an uprising in the district, at

the time of our landing in Burma, government officials had informed us that it would be unsafe for any whites to venture into this section. During our ten days' absence in the vicinity of Taungdwyngii and Kokkogen, however, matters had quieted down, and we were permitted to go, but were advised to complete our work and get out as speedily as possible.

Unfortunately, three native servants of an English official had been murdered at the forest bungalow we were to occupy. We tried to keep this from our boys but, upon coming in contact with the natives at the new camp, they soon learned all the uncanny details. With much reassurance of their safety and with our permission that they be allowed to occupy a large room in the bungalow across from our quarters, they seemed to be quieted for the time. But we found on the following morning that they had barricaded their doors and armed themselves with every available weapon for protection in case of emergency.

The forests about Insien are matted with a heavy large-leaved vining bamboo known as wathabut, among which are scattered huge banyan trees, wild bananas, and other palms. An occasional tree massed with purple flowers rising out of the tangled impenetrable wathabut in the morning mist of the Insien forest was a sight to remember. It was of surroundings such as these that we made our records, for it is among vegetation like this that the rhinos live.

We would have been willing to spend far more time amid the beauties of the bamboos than our work required, but our schedule pressed us, for we were to sail for the Seychelles and East Africa, there to gather still other backgrounds. So pleasant had been our task that even our native boys seemed downcast at our leaving. They had proved willing, intelligent, and faithful, and even across the gulf that constantly exists between the lower classes of the East and the "Sahibs" from the West, we felt the friendliness of these sincere and gentle people, as, we hope, they felt ours for them. They returned kindness with kindness and consideration with consideration, with the result that we remember them very pleasantly indeed, as we also remember all the jungle land of Burma in which these gentle people dwell.

THE RAILROAD STATION AT TAIKKYI
Showing the bullock carts that brought the expedition equipment from the last camping place in Burma

FISH AND FISHERMEN OF CORNWALL

How the Periodic Visits of the Pilchards Support an Active Industry—The Fish, the Fishermen, and the Fishing Luggers

By EDWIN PENGELLY
Second Officer, S. S. "Minnewaska"

SINCE the closing of the tin and copper mines of Cornwall, the pilchard fishery has become the principal and most profitable industry of that beautiful and historic little Duchy.

Peculiar as it may seem, the small, dainty pilchards (*Clupea pilchardus*) seldom if ever visit any other waters along the British coast. Rarely are they sought or caught in waters eastward of Start Point, that well-known promontory on the English Channel, or in waters above Padstow in the Bristol Channel. Their rendezvous appears to be confined to the coasts and bays of the western corner of Britain. The principal places frequented by them are Whitsand Bay, Par Bay, Mounts Bay, St. Ives Bay, and the many coves along the shore.

Although for many years I was engaged in the business of pilchard fishing, and therefore was personally interested in the habits and customs of these little fellows, I never solved the reason why they regularly visit this neighborhood, or what the attractions are, yet it must be admitted that some suitable attraction must exist. It may be the nature of the sea bottom or the small bait the pilchard follows when in search of food. Like the herring, the pilchard feeds upon minute crustacea and other animals, some adult, some larval, which swarm in the sea. Whatever the attraction may be, or from whatever part the pilchards may migrate, the fact remains that they visit these coasts as regularly as do the swallows and the cuckoos, coming from the south and staying their appointed time for the benefit of the fishing folk, as it were.

The pilchard is of the same family as the sardine which abounds off the coasts of Portugal and Spain. The sardine is from five to eight inches long, while the pilchard is ten inches. In appearance it resembles the herring, but is rather thicker and its scales are larger. The under jaw of the pilchard is longer than the upper, the mouth is small and, in the adult fish, is destitute of teeth. The back is of a bluish green, the sides and belly silvery white, the tail dusky, and the gills tinged with a golden yellow.

To distinguish the pilchard from the herring is an easy matter. Hold each of them by the dorsal fin with the forefinger and thumb. The pilchard will drop by the tail, and the herring by the head.

When in deep water, pilchards swim at a depth of forty to sixty feet, yet they will approach the shore in less than six feet of water. At times they have been caught in the breakers and thrown high and dry upon the beach. They have also been caught in the pools at half tide and at low water.

The pilchards are generally sighted during the month of July from twenty to thirty miles south to southwest of the Eddystone Lighthouse. They appear in numerous shoals, and in fine weather can be seen playing on the surface, though the bulk of the shoal is at some considerable depth. These shoals are accompanied by gulls and gannets, ever watching for an opportunity to snatch any little fellows that are brave enough to show themselves above the water.

When sailing directly over a large body of pilchards, one can see myriads of tiny

bubbles rising to the surface, and the course and direction the fish are making can be ascertained beyond doubt by watching the shoals carefully, each day finding them nearer land. After the lapse of a couple of weeks or so, the fishermen, whose livelihood depends so much on the industry, can be seen preparing their nets and fitting out their boats, which are then held in readiness.

The ports of Looe, Polperro, and Mevagissey are the most important, as each has a fleet of about forty sailing smacks and motor boats engaged in the industry.

By the first week in August the pilchards arrive within easy reach of the fishing fleets, about six miles from the land. The first comers being young fish, about three years old, are rather small, and nets with meshes running thirty-four to thirty-six to the yard are used. As the season advances, older and larger fishes arrive; then nets having thirty-two meshes to the yard are more suitable.

The sojourn of the pilchards may be divided into two distinct seasons, the summer season and the winter season. The change of seasons occurs between the months of September and November, and is as regular as the changing of the monsoon in the Indian Ocean. When the summer season sets in, large fleets of boats ply to and from the fishing grounds daily. Each day lessens the distance until a well-known saying of the fishermen becomes an accomplished fact, viz: "Corn up in shocks, pilchards in to rocks."

Whitsand Bay now becomes literally full of these fishes, and small open row boats will put out from less important ports and return in a short time heavily laden. At this period the excitement waxes great, as catches ranging from 500 to 60,000 are often taken. At times

FISHING LUGGERS LEAVING THE HARBOR OF LOOE

From several of the tiny ports of Cornwall these sturdy vessels operate. The schools of pilchards are followed and the fish are caught in gill nets

the catches are so heavy that the nets are carried to the bottom by the sheer weight of the fish, entailing great loss to the owner.

This continues in Whitsand Bay for about three or four weeks, the pilchards alternately heading toward the shore during the daytime and turning seaward an hour or so after sunset. On a calm and quiet evening the rush seaward can be heard at a great distance. The noise is almost musical, and resembles the sound of a fast-running stream tumbling over rough pebbles.

Early in September the pilchards take their final departure, and so complete is the exodus that only a few fish remain in the bay. Seldom do they change their track, the course each year being midway between Eddystone and the Rame Head. Although I have traveled across the North and the South Atlantic Oceans many times, never have I observed any signs of shoals of pilchards. This gives me reason to believe that they remain inside the hundred-fathom line of soundings, and that their spawning ground is some fifty or sixty miles from the Cornish coast. The ova, unlike those of the herring, are quite transparent and buoyant, and they pass through their development while suspended separately in the sea water.

The fish are captured by means of drift nets and seines. The most favorable time for using the net is between dusk and dark, at the rising and the setting of the moon, and again at early dawn. Change of tide also affects them, the high and low water slacks being most favorable as the nets then lie perpendicular on the water.

Most of the pilchards landed are salted for the Mediterranean market, especially

"SHAKING OUT THE PILCHARDS"
The decks of the successful luggers are covered with thousands of pilchards while the men are engaged in landing their catch

LUGGERS IN THE HARBOR OF POLPERRO

Heavy weather is not uncommon off the coast of Cornwall, but the perfect little harbors of the fishing ports protect the fleets in periods of exceptional storm; the luggers are amply able to care for themselves at other times

for Italy and Sicily. Formerly they were cured dry, but at present the salting is carried out in large concrete pits or tanks, so that the brine formed rises over the fish and they are kept steeped in the liquid for several weeks and sometimes months. Women wash the fish and then pack them into barrels in a most unique manner, with the heads toward the center, layer upon layer. They are then placed under well-devised screw presses attached to horizontal beams. This process continues until the contents reach a required weight. The oil collected as the result of this pressure is sold principally for the use of leather dressers.

From 48,000 to 60,000 half-casks of these cured pilchards are exported annually, each containing 720 to 750 fish, according to size, and weighing from about 120 to 123 pounds gross.

The winter season begins in November of each year, the winter pilchards arriving from the south and southwest as did the summer fish, and also accompanied by gulls and gannets.

It is not unusual for whales to follow the winter shoals. They are not welcome visitors, for occasionally they do irreparable damage to the nets.

The winter fish are older and therefore larger and firmer than the summer pilchards. They rarely enter the shoal water of the bays, but prefer to keep at a more respectful distance from the shore.

Success of the winter season depends chiefly upon weather conditions. Should fair weather prevail with north and northwest winds, the sea water become too clear. If, however, the southwe gales are persistent and accompanied by heavy rains, the sea water is muddied by the river freshets, and larger shoals of pilchards will approach the land, thus assuring a more profitable winter season for the fishermen.

As a rule December or early January

A PART OF THE POLPERRO FLEET PUTS TO SEA

Out past the "Peak Rocks" the little vessels sail, in order to set their nets and take their toll of the pilchard schools. Alternately setting and hauling in their nets, the fishermen work strenuously while they are at sea filling the holds of their luggers to overflowing

FISHING BOATS AT LOOE

Smaller than the fishing smacks that sail from Gloucester and the Nova Scotia Coast to the Grand Banks, these luggers are nevertheless sturdy and seaworthy, for though they do not venture far to sea in their pursuit of pilchards, they often face rough weather and boisterous seas

LOOE, AS SEEN FROM THE DOWNS

During periods of pleasant weather, when the fishing fleets are in port, the luggers are often anchored outside the little harbor. A blow, however, brings them in past the "Banjo Pier" to the protected reaches of the tiny inlet

THE INNER HARBOR AT POLPERRO

The great rise and fall of the tide in the English Channel is a definite factor in all nautical activities. In the picture some of the more distant boats can be seen to be "high and dry," which is common enough in these ports at low tide

A LADEN LUGGER ENTERING THE HARBOR OF WEST LOOE
So restricted are the fishing grounds on which the pilchards are taken that only a few of the many English Channel ports take an active interest in the business

marks the last of the pilchards; and they follow the same track as did the summer fish, apparently for the spawning ground.

The pilchard is found near shore in more or less abundance from July to January. During March and April and into May, when as a rule none are taken near the shore, spawning pilchards are found some distance out. At this season a few are taken occasionally in mackerel nets, in which the larger ones are meshed in consequence of their swollen condition.

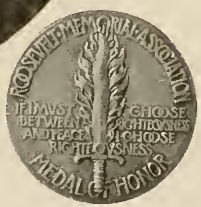
A FISHERMAN OF CORNWALL

FRANK M. CHAPMAN

A Scientist Who Has Shared His Knowledge

By STEWART A. McWILLIAMS

IN recognition of his work for the promotion of Natural History Dr. Frank M. Chapman, curator of the department of ornithology in the American Museum of Natural History, in company with Charles Evans Hughes, former Secretary of State, and Charles A. Lindbergh, was presented with the Roosevelt Medal for Distinguished Service this year on October 27, the seventieth anniversary of President Roosevelt's birthday. The award was haled by the press and public all over the country as being highly deserved, for the career of Frank M. Chapman, scientist, writer, lecturer, editor, explorer, photographer, pioneer in modern museum exhibition, and diplomat, has been extraordinarily rich in service and value to his fellow men.



FRANK M. CHAPMAN AND THE ROOSEVELT MEDAL

He has long been known as the man who made America conscious of its birds.

The Roosevelt Memorial Association, in announcing the award of the medal, declared that Doctor Chapman "has had more influence than any other man in America—and probably than any other man in the world—in making ornithology a popular subject which has entered into schools and homes and has become part of the education of countless numbers of men, women and children."

When he wandered about the American Museum as a boy, he found thousands of birds mounted on T perches and was obliged to search blindly to find those he had seen in real life. Later, when he joined the American Museum staff he immediately arranged a collection of the local birds found near New York City. The exhibit is still used, being changed each month as the local bird population shifts.

In an address delivered before the International Congress of Ornithologists in London, in 1905, Doctor Chapman presented a creed which, slightly paraphrased, could well be used as the universal code for all scientists and museums:

"That science which is sufficient unto itself has no excuse for its existence. If our studies of birds have no bearing on the progress and welfare of mankind they are futile. That they have such a bearing, and in an exceptional degree, we know to be undeniable; it is obviously, therefore, the function of the Museum to demonstrate this connection in such a manner as to render apparent the bird's place in nature and its relation to man."

His creed explains many of his achievements. From it grew the dream of habitat groups—of birds mounted naturally in

surroundings just as they are in life.

The resulting groups inaugurated a new method of museum exhibition, for, with the exception of the "Four Seasons" deer group in the Chicago Field Museum and a few less important groups in the Milwaukee Museum, all executed by Carl Akeley, they were the first attempt at the use of habitat groups on a comprehensive scale. The method, copied by museums all over America, has given new life not only to bird study but along other lines as well.

In the American Museum, Doctor Chapman has carried out his dream so well that the visitor looking at the North American bird groups is also conducted, by means of the paintings in the backgrounds, on a tour of the country.

The committee on whose recommendation the Trustees of the Roosevelt Memorial Association made the award, regard Doctor Chapman's scientific achievement as three-fold. They believe that "through his comprehensive studies of South American bird-life he has conceived and elaborated an entirely new method of ornithological research, and more than any other student has pointed out the evolutionary relationship of the forms of life inhabiting successive altitudinal zones in the Andean system."

The Andes are now known as a recent annex to the world—formed at a time for which we have a fairly definite geologic date. The many species restricted to their upper life zones have evolved since the mountains arose. Doctor Chapman was one of the first to realize the importance of studying the distribution and origin of their life.

Paying tribute to his other activities, the committee extolled Doctor Chapman's skill and charm as a lecturer and writer, and his ability as a bird photographer where he has again been a pioneer in devising some of the modern methods of the use of blinds for photography, and mechanical devices to make birds and animals take their own pictures.

With his creed ever in mind he has written frequently and exhaustively on bird life—written so well that the thousands of copies of his books are eagerly sought both as a source of entertainment and as standards in their field. He is the founder and editor of *Bird-Lore*, now in its thirtieth year, the foremost popular bird magazine of the country and organ of the National Audubon Society.

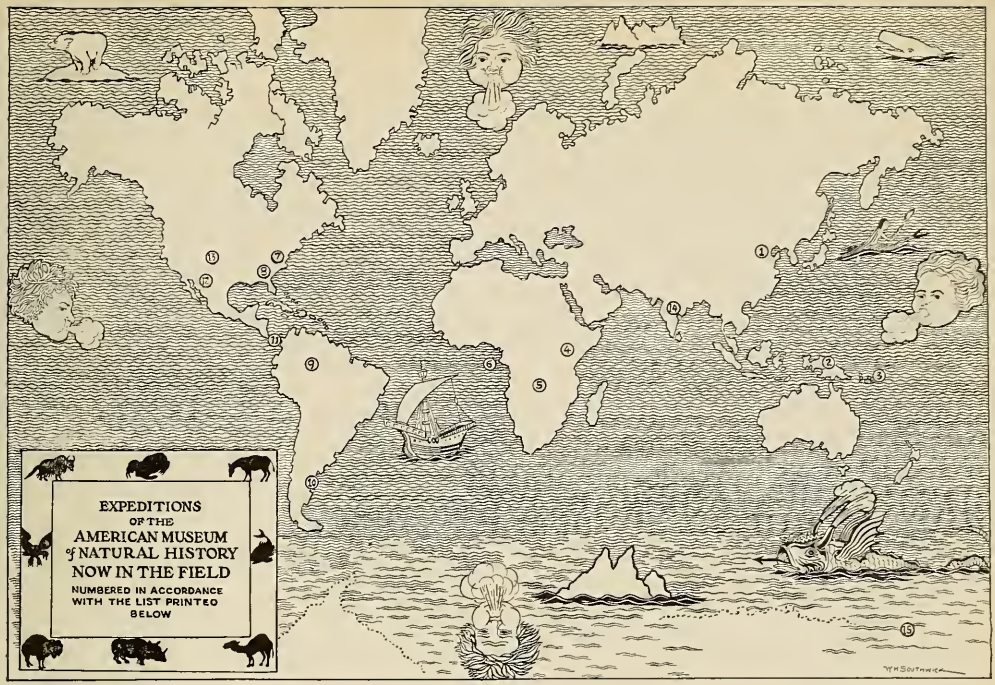
Doctor Chapman's entire scientific career has been spent on the staff of the American Museum of Natural History. During those forty years of noteworthy service he has constantly displayed qualities as a man which have endeared him to those people with whom he has come in contact, and have made his presence a source of pleasure as well as honor to the Museum.

His rare combination of personal qualities and ability fitted him well for the difficult diplomatic task he assumed in 1918 as American Red Cross Commissioner to South America.

He is the second member of the Museum staff to receive the Roosevelt Medal in the five years the awards have been made. In 1923, Prof. Henry Fairfield Osborn, president of the Museum, was presented with the medal personally by President Harding in the White House.

Especially noteworthy among Doctor Chapman's honors are the presentation by the National Academy of Sciences, in 1918, of the first Elliot Medal, awarded annually for pre-eminence in zoölogy or palæontology, and the award of the first Linnæan Society Medal, in 1912, for general achievement in natural history.

Many have been the honors accorded him by the scientific world for his achievements, but the universal and highest tribute of all is that paid by an entire generation of people who think of him as a scientist who constantly endeavors to share his knowledge.



IN THE FIELD OF NATURAL HISTORY

Expeditions — Scientific Research — Conservation
Books — Meetings of Societies

EDITED BY A. KATHERINE BERGER

THAT the readers of NATURAL HISTORY may have the latest available information regarding the field activities of the American Museum, NATURAL HISTORY purposes to indicate on the above map as nearly as possible the whereabouts of the major expeditions in operation at the time the magazine goes to press.

The numbers within the circles coincide with those given in the following list:

1. Central Asiatic.
2. Beck, New Guinea, for birds.
3. Whitney South Sea, Solomon Islands for birds.
4. Carlisle-Clark, for birds and mammals.
5. Tanganyika, for birds and mammals (J. S. Rockefeller and G. B. S. Murphy).
6. Sao Thomé, for birds (Thorne-Correia).
7. Chester A. Reeds, Lake Passaic varves.
8. William G. Hassler, Allegheny Mountains, for salamanders.
9. Tyler Duida, Venezuela, to collect birds and mammals.
10. Southeastern Brazilian Expedition (Naumberg-Kaempfer).
11. East Panama, for birds (Benson).
12. Santa Fé, for fossils (Frick-Rak).
13. Keams Cañon, Arizona, for fossils (Frick-Blick).
14. Vernay-Faunthorpe for Asiatic mammals.
15. Byrd Antarctic.

EXPEDITIONS

CENTRAL ASIATIC EXPEDITION.—The 1928 season of the Central Asiatic Expedition has been brought to a successful conclusion, and Dr. Roy Chapman Andrews has secured permission from the Nationalist Chinese Government to ship the fossil material to the American Museum. President Osborn will present the scientific results of the season's work in the January–February issue of NATURAL HISTORY.

THE BYRD ANTARCTIC EXPEDITION.—Four ships, the "City of New York," the "Eleanor Bolling," the "Sir James Clark Ross" and the "C. A. Larsen" are carrying, by various routes, Commander Richard E. Byrd and his gallant crews of Antarctic crusaders across the Pacific Ocean to their intermediate base at Dunedin, New Zealand, longitude 170° E., latitude 46° S. The "C. A. Larsen," the last ship to leave the United States, sailed from San Pedro, California, on October 10, and joined the other ships at Dunedin November 5.

When the last stores have been loaded, the four ships will be directed southward toward the Bay of Whales, a bight in the Ross Sea, in longitude 160° W., latitude 78° S. This is the southernmost extension of marine waters into the ice-shrouded shores of the Antarctic continent, a land as large as either Canada, the United States, or Australia. The approach to the open stretches of the Bay of Whales will be a slow and difficult one, for a barrier of pack ice some 800 miles in width and studded with huge icebergs, lies across the route south of New Zealand. Except at the Bay of Whales, and a few other places, cliff-like walls of ice one hundred to two hundred feet high rise sheer from the icy waters along the Antarctic coast. The places where an exploring party and its equipment may be landed from ships are thus relatively few in number. Commander Byrd expects to arrive at the Bay of Whales with his ships about December 20, that is, at the beginning of summer in southern latitudes.

Much effort has been expended during the past year in organizing, financing, and equipping this large American expedition, and with four aëroplanes, various dog teams, the most modern of scientific equipment, and a well selected personnel, it is anticipated that much data of a scientific nature, chiefly geographical, will be gathered during the two years that the base camp is established on the low lying Great Ice Barrier near the Bay of Whales.

The American Museum is one of the scientific sponsors of the expedition, making available all the scientific resources of the Museum, as well as the counsel of members of its scientific staff.

With the expedition's winter quarters some 880 miles distant from the South Pole, and about 10,000 feet below it, attempts will be made by aëroplane to explore the region to the south and southeast of the base of operations.—C. A. R.

The Stoll-McCracken Expedition.—On October 18 the members of the Stoll-McCracken Expedition returned to New York, arriving by train from Prince Rupert, British Columbia. The expedition schooner, the "Morrissey," will go around by way of the Panama Canal, and Capt. Robt. A. Bartlett expects to reach New York after about two months at sea.

The most important results of the expedition were the collecting of a splendid group of the Pacific walrus (males, females, and young), a group of Arctic sea birds (with Little Diomede Island as the habitat), four specimens of the so-called mummies of the Aleutian Islands (very interesting native burials which promise to disclose important data when intensively studied), several specimens of the large Alaskan brown bear, in addition to study collections of small mammals, birds, and fish. A complete photographic record of interesting features of the work was also secured.

When the schooner broke her propeller shaft in Bering Sea, and the following three weeks were lost in the consequent repairs, it became necessary to give up the plan to reach the Kolyma River, and the itinerary as far as it pertained to Siberia was canceled. It is doubtful whether the party could have worked on the Kolyma had there been no accident to the shaft, for the ice came down into Bering Strait before the end of August and shut off all access to or from northeastern Siberia. An account of some of the most interesting features of the expedition will appear in an early number of Natural History and Mr. McCracken will lecture on "The Morrissey's Search for Arctic Mummies" in the American Museum Members Course, on December 20.

The expedition was organized by Harold McCracken, who acted as leader, and Charles H. Stoll, the financial backer of the enterprise. Mrs. Stoll accompanied her husband and took an active part in the season's work. The scientific staff was in charge of H. E. Anthony, curator of mammals in the American Museum, and included F. L. Jaques, artist and preparator, Andrew Johnstone, taxidermist, and Edward Weyer, archæologist. Capt. Robert A. Bartlett was the skipper in command of the schooner "Effie M. Morrissey."

The Carlisle-Clark African Expedition.—News from the Carlisle-Clark African Expedition indicates its complete success in obtaining exceptionally fine specimens of lions for the African Hall in the American Museum. The energies of the members were also devoted to animal photography, and Mr. Leigh, the artist, made a series of sketches of typical lion country, which will be used as studies for the background of the new group.

Dr. Margaret Mead, assistant curator of ethnology at the American Museum, started for Australia in September, as a Fellow of the Social Service Research Council, to make a study of the mental development of young children among primitive people. She expects to visit the Bishop Museum in Honolulu, the Auckland and Wellington museums in New Zealand, and the Sydney Museum, en route. Her study base will be in some village in the Bismarck Archipelago, probably in the Admiralty Islands, where she will also collect ethnological specimens and photographs.

COVER DESIGN OF "NATURAL HISTORY"

THE SACRIFICE TO THE WAR GOD.—The cover design for this number of NATURAL HISTORY was painted by Mr. A. A. Jansson of the American Museum staff, and represents the elaborate ceremonial and religious life of the Aztecs. A ruler is receiving the homage of a conquered foe who later, with his comrades, will be offered up as a sacrifice to the war god. This cult was halted by the Spanish conquest in 1519, shortly after it was established. The demands for victims introduced a series of campaigns by the Aztecs in all directions from the Valley of Mexico to gather more captives to satisfy the increasing requirements of the deity.

APPRECIATIONS OF CARL AKELEY

MRS. MARY L. JOBE AKELEY, advisor and assistant in the work for the Akeley African Hall, was received with Dr. J. M. Derscheid, the Belgian zoölogist, in private audience during the evening of October tenth in the Royal Palace in Brussels by His Majesty, Albert, King of the Belgians, and by the Duke and Duchess of Brabant. At this audience, as a result of the work of the Akeley-Derscheid African Mission of 1926, plans for the organization of the Parc National Albert in the Kivu Belgian Congo were presented, and Mrs. Akeley showed the motion pictures of gorillas and the volcanoes, which Carl Akeley secured on his 1921 expedition.

Returning through London, Mrs. Akeley lectured at the Zoological Society, to the Society for the Preservation of the Fauna of the Empire, at the invitation of the president, Lord Onslow. Her lecture dealt with the findings of the Akeley-Derscheid mission in the Parc National Albert, with plans for conservation of the flora and fauna of this region, and with the possibilities for international scientific research therein.

BARON DE CARTIER PAYS TRIBUTE TO CARL AKELEY.—At the fiftieth anniversary of the activity of the Baptist Missions in the Congo region, celebrated in London, June 8, Baron de Cartier de Marchienne expressed his admiration of the devoted work of evangelical, educational, moral, and social uplift which had been carried on for many years in the Belgian Congo by the Baptist Missionary Society. He closed his speech with an appeal for conservation of Africa's natural beauties and paid the following tribute to the work of Carl Akeley:

> But it is not enough to develop in every way the country, we must also prevent its natural beauties from being lost or irremediably altered.
>
> In this way I take pride in calling your attention to the great thought of King Albert, who decided that certain parts of the Colony, particularly interesting for their flora and fauna and the natural beauty of their surroundings, should be preserved forever under the trusteeship of the Nation.
>
> Thus was founded the Parc National Albert. It includes, as you know, the volcanic regions of Lake Kivu with its magnificent scenery, which the late Carl Akeley first revealed to the world.
>
> Permit me to pay tribute here to the memory of Carl Akeley, the greatest naturalist and conservationist the world has ever known, and who now rests on the slopes of that mountain of Mikeno that he loved so well. You will all recall his tragic death in Kivu, where he had been sent on a special mission by that noble organisation, the American Museum of Natural History of New York.
>
> You will recall also that his widow courageously carried on his work to a most successful conclusion.
>
> If I speak of my friends, Mr. and Mrs. Akeley, it is that I see in their case a new example of that idealism which, so to speak, flourishes naturally in all spheres of human activity in the Congo, and to which, no doubt, its religious, social, and economic development is so largely due.

AKELEY ELEPHANT SCULPTURES DESIRED FOR JOHANNESBURG.—MR. GERARD MOERDYK of Pretoria, South Africa, architect for the new railway station and the surrounding plaza at Johannesburg, recently visited the American Museum to commission Carl Akeley to design two African elephants to be cast in bronze in South Africa and placed before a sixty-foot arch at the head of the avenue approaching the new station. It was not until he was on the ship that brought him to New York that he learned of Mr. Akeley's death.

ASTRONOMY

STUDY-GROUPS under the leadership of able directors are being planned by the Amateur Astronomers Association for the discussion of topics of common interest in various branches of astronomy.

HONORS

DR. FRANK M. CHAPMAN, curator-in-chief of the division of zoology and zoogeography of the American Museum, has been awarded, in company with Charles E. Hughes and Charles A. Lindbergh, the Roosevelt Medal for Distinguished Service. It was bestowed on Doctor Chapman in recognition of his remarkable work in promoting the popular study and conservation of bird-life. The presentation was made by James R. Garfield, president of the association, and the citation was given by Mr. Herman Hagedorn. Mr. Hagedorn in citing Doctor Chapman's qualification for the medal said:

> For the medal for distinguished service in the promotion of the study of natural history, Mr. President, I have the honor to present a name which is beloved wherever in America, in school or home, the birds are permitted to come down from the tree tops to be the companions of men; a writer and lecturer of persuasive charm, who has taught a nation to see, to know, to love and to protect the entrancing and forever mysterious familiars of its daily life; a creative innovator in methods of exhibition and of ornithological research; a scientist, wise and unsatisfied, whose laboratory is a wilderness of Andean peaks, where fluttering wings betray to him things secret since the beginning of time.

Doctor Chapman acknowledging the presentation, said in part:

> To have one's life-work stamped with approval by an organization that cherishes the ideals and is governed by the standards of Theodore Roosevelt is indeed a high reward. Only the commendation of Mr. Roosevelt himself could be higher.

I accept this medal, therefore, Mr. President, with a full understanding of the honor its brings, not alone to me and to the science I represent, but to those good citizens in feathers whose claims to our protection and friendship are yearly becoming more widely acknowledged. And certainly to no layman is Citizen Bird more deeply indebted for this recognition of his rights than to Theodore Roosevelt. It was Mr. Roosevelt's good fortune to be born a bird-lover; it was the world's good fortune that he was also born a great many other things. But the demands of many callings never crowded the bird from his heart, and in that remarkable complex of individuals who in the aggregate made Theodore Roosevelt, the naturalist always held his own.

. . . . . .

It was his surprising ability to prevent conflict among his many absorbing interests that enabled Mr. Roosevelt to keep in touch with the literature of those branches of natural history that appealed to him, as well as to maintain contact with naturalists. Indeed, one may say that there was a natural history cabinet as well as a tennis cabinet. Most of its members lived in Washington, but when need arose, a scientist who was especially qualified to meet it might be called from elsewhere. As, for example, when Professor Osborn went to Washington for consultation on the Romanes Oxford address—'Biological Analogies in History'—which was prepared, by the way, with characteristic forehandedness a year and a half before the date set for its delivery.

This conference with a recognized authority was a characteristic habit. I have seen Mr. Roosevelt cross-examine a leading scientist on the Mendelian laws of inheritance, for example, with a series of questions that went to the very core of the problem. At such times all his mental forces were focused on the subject at issue, with an intense concentration which revealed not alone his method of acquiring, but his secret of retaining, information. Without going further, it is evident why, wholly aside from the fact that he was Theodore Roosevelt, Mr. Roosevelt exerted, and will continue to exert, a marked influence as a naturalist.

In the field of ornithology this influence was most effectively shown as an appreciative, sympathetic observer and recorder, as an explorer and as a conserver. By word and deed Mr. Roosevelt taught us the value of the bird in its haunts, not alone to the student, but to the nature lover.

. . . . . .

Above all Mr. Roosevelt emphasized the need for accuracy of statement in recording observations. The nature writer who presented fiction as fact he branded as a nature fakir so effectively that writers of this class have not yet risen to the rank of a low-type criminal!

As a hunter of big game and explorer Mr. Roosevelt included in his expeditions to Africa and South America museum men who could preserve the animals killed and also make general collections. This admirable procedure has not only become a family habit, but it has been so generally adopted by hunters and travelers that our museums actually cannot meet the demand for assistants of this kind.

. . . . . .

But doubtless our greatest debt to Theodore Roosevelt the ornithologist, is as a conserver of bird-life.

Of the eighty Federal bird reservations now existing, fifty were established during his administration.

AMPHIBIANS, REPTILES, AND EXPERIMENTAL BIOLOGY

Experiments with the Pike-headed Newt.—The department of herpetology and experimental biology at the American Museum has been very successful in keeping large quantities of living animals in good health. During the past summer, one of the rarest salamanders in the collection bred continuously for several months. This species, *Triturus rusconi*, popularly called pike-headed newt, is found only in the high altitudes in Sardinia, where it breeds in the mountain streams. The department has been experimenting with a series of this species for some months while studying the causation of color patterns.

Females which were kept in tanks of running water laid their eggs between and under the stones. The eggs were not attached by stalks, as in the case of all our American salamanders which breed in mountain brooks. The stalkless egg is characteristic of lowland newts, and the fact that this Sardinian mountain newt should have retained very much the same type of egg, although breeding in mountain brooks, is evidence of its ancestry.

Europeans have several times before succeeded in making the Sardinian newt breed in captivity, but this is the first time the species has bred in America. The department's new laboratory is planned to induce many other species to breed, with a view to working out many important details of life history.

Color Variations in Mountain Salamanders.—Mr. William G. Hassler spent three days in the field at Durbin, West Virginia, during October. In this short time he made a record catch of 879 salamanders, as well as various reptiles, and brought the whole series back to the Museum alive. The field work was undertaken to learn more about several color varieties of the mountain salamander, *Desmognathus fuscus carolinensis*. At Durbin the subspecies exhibits enormous variations,—individuals uniformly orange in color, yellow with zigzag cross stripes, and reddish with black longitudinal stripes being found together under one stone. The mountain salamander seems to be in the act of mutating in this region, and the large series brought to the Museum will be used in experimental investigations concerning the origin of some of these variations.

Salamander Eggs for Experimental Biology.—A shipment of 1600 living eggs of the giant salamander, *Cryptobranchus*, has just been received by the department of herpetology and experimental biology. These are to be used in a variety of studies. Amphibian eggs are ideal for determining the mechanics of development. The epoch-making discoveries of the German embryologist Spemann, on the "organizers" of development, have been perhaps the greatest contribution of recent times to the field of embryology. This work was carried on with amphibian eggs not one tenth the size of the eggs just received by the department.

Cryptobranchus breeds in the Allegheny Mountains, and the present shipment came from southwestern Pennsylvania. They were laid under rocks in the mountain streams, and as shown in an exhibit in the new Reptile Hall, the males guard the eggs until the young are hatched.

Blindness in Cave Animals.—Byron C. Marshall, who has been studying blind salamanders in the caves of Missouri and Arkansas, brought back with him a supply of several hun-

dred specimens for use in the experimental work now being carried on by Dr. G. K. Noble of the department of herpetology, to determine the causes of blindness in cave animals.

LOWER INVERTEBRATES

THE NEW ROTIFER GROUP.—A new group was formally opened to the public in the Darwin Hall of the American Museum on October 10. It is known as the Rotifer Group, and is a companion piece to the Bryozoa Group, which shows two inches of sea bottom magnified 25 diameters. The Rotifer Group, designed by Dr. Roy W. Miner and constructed under his direction, presents to the observer the microscopic life found in one half inch of pond bottom as one would see it through a microscope magnifying cubically one million times. The myriads of minute living creatures in association with plant life that crowd so small an area are shown intent on catching and devouring their prey, struggling to avoid being caught and devoured themselves, and reproducing their kind, even as the creatures of the visible world crowd their larger environment, seriously engaged in the business of living. The most conspicuous beings spinning about in this aquatic world are the rotifers or "wheel-bearers," microscopic animals with rows of vibrating cilia wreathing their heads. These are shown in all their diversifications, and the entire exhibit has been planned with a view to revealing to the uninitiated observer just what a rotifer is and does.

Most of the organisms possess a texture and coloring so translucent and delicate that glass is the only medium capable of reproducing them naturally. The remarkable glass modeling of the group is the work of Herman O. Mueller of Doctor Miner's staff of artists. The delicate coloring of the models and background was done by Mr. W. H. Southwick, while the wax reproductions were modeled by Mr. Chris E. Olsen.

The field work was largely carried on at Mt. Desert Island, Maine, by Doctor Miner in collaboration with Mr. Frank J. Myers. The field color sketches were prepared by Dr. George H. Childs under Doctor Miner's direction.

"SIMBA' WINS BRITISH APPROVAL

BRITISH PRAISE OF "SIMBA."—British appreciation of the Martin Johnson film, introduced in London under the name "Safari," has been enthusiastically voiced in the *London Times* and in the *London Spectator*.

Baron de Cartier de Marchienne also saw the film in London, and wrote President Osborn the following personal tribute:

> Last night I witnessed at the Palace Theater the marvelous film taken by Mr. and Mrs. Martin Johnson and depicting wild life in British East Africa.
>
> I just want you to know that the audience was very enthusiastic and very deservedly so, as I am positive that I was never privileged to see such a wonderful cinematographic production as "Simba."

NEW PUBLICATIONS

Trails of the Hunted. By James L. Clark, pp. 310. Illustrated with photographs. Little, Brown, and Company, Boston, 1928.

To be charged by buffalo, rhinos, lions, and elephants, is experience—to live through many charges and to write observingly and modestly of these, is accomplishment. Mr. Clark's semi-biographical volume is rich in the thrill of close association with big game, game so often dangerous to the hunter. The trails have led through three great continents, and each has yielded great game. Africa has furnished the finest material for this book. No one could put down the volume while reading of the breathless night when Clark and Dugmore crawled out of their thorny *boma* to replace the flashlight charge exploded just before by a lion at the kill, or when stampeding elephants charged back and forth in search of the man who had climbed as high as he could in a small thorn tree in their midst.

Having gone to East Africa while its vast herds of game were still magnificent in their proportions, before the modern slaughter was too well under way, the author had opportunity that no one now may have. Since then he has gone twice again. Always with the eye of an artist and a taxidermist who must observe enough to reconstruct later that which he has seen, his memory has not failed him in this accounting. African hunting books are many. Few compare with Clark's.

America might seem an unexciting place to hunt. Yet the author considers our giant Alaskan bear the most powerful of all carnivores and one at least as dangerous as the lion. Nor are there animals more difficult to hunt than our mountain goats and sheep. American game is not neglected.

With W. J. Morden, the writer hunted the greatest of all sheep, the *Ovis poli* of the high Pamirs. On this trip across central Asia the hunters became captives of the Mongols. After several days of torture they escaped with their lives, but with memories of an experience that cannot help but enrich a life of high adventure.

Opportunity came to Mr. Clark and he made the most of it. His book is ample testimony.

—R. T. HATT.

A Re-Study of some of the Ordovician and Silurian Cephalopods described by Hall. By August F. Foerste, Denison University Bull. Vol. XXIII, 1928)

NEW VERSUS OLD CEPHALOPOD SPECIES—Within the last few years many new species of

cephalopods have been described from such regions as Greenland, Manchuria, Yunnan, and Burma. Many of these new species either do not fit into the zoological classification in vogue, or when they are included, the classification no longer serves its purpose. In either case new genera, new families, and new classes must be erected, for the study of this new material has cleared up obscure points in the anatomy of this group. It has also added enormously to our knowledge of the oldest representatives of this very important class of invertebrates.

Unfortunately this increasingly fine classification of new material has not always been extended to old species. As matters stand at present, our knowledge could be greatly increased by the re-study of the collections made by the earlier geologists. These old collections, for the most part, remain classified according to obsolete standards and are consequently inadequately catalogued.

In recent years Dr. August F. Foerste of Dayton, Ohio, has made a re-study of American Silurian and Ordovician cephalopods. From time to time he has issued short papers proposing new views and theories for the criticism of his scientific colleagues, and described more completely and accurately older species. The latest of these papers is devoted to the re-description and re-classification of a part of the James Hall collection of cephalopods in the American Museum. Forty-one species are described, of which seven are recognized as new. Two new genera have also been erected. The greater number of these species had not been re-studied since 1861, some as early as 1847. During the summer of 1928, Doctor Foerste studied similar collections in the museums of Petrograd.

Laboratory research of this sort lacks the excitement attending the exploration of new areas, but it is as important to the advancement of science, and far less expensive. Moreover, there are many other species of fossil invertebrates in the older collections of the American Museum whose re-study would be of special interest to science.—C. A. R., and J. W. M.

CONSERVATION

A FORWARD STEP IN WILD LIFE CONSERVATION. A meeting of great importance with respect to the fortunes of wild life in our country was held in Seattle, Washington, August 27–31, 1928. This was the annual Convention of the International Association of Game, Fish and Conservation Commissioners, which was held jointly with the Western Association of State Game Commissioners and the American Fisheries Society. Among the many questions up for discussion none was of greater interest than that of what stand the Conservation organizations of the United States should take in reference to the two Game Refuge Bills pending in the lower House of Congress.

So great was the importance attached to this subject that an extended hearing was given, as a result of which Dr. T. Gilbert Pearson, as chairman of the Resolutions Committee, submitted the following resolution, which was unanimously adopted:

"WHEREAS, in our opinion there exists a great and urgent need for the establishment and maintenance of a number of inviolate sanctuaries for the protection of migratory wild fowl and shore-birds; and

"WHEREAS, we believe it to be the duty of the Federal Government, in carrying out its treaty obligations, to make provision for the creation of such reservation areas; and

"WHEREAS, we believe that reservations of this character should be acquired and financed by congressional appropriations; therefore be it

"*RESOLVED*, That the International Association of Game, Fish, and Conservation Commissioners, and the Western Association of State Game Commissioners representing the official state game departments in twenty-eight states which are here present and voting, do hereby jointly endorse in principle the provisions of the Norbeck Bill as approved by the United States Senate in May, 1928; and be it further

"*RESOLVED*, That to carry out the wishes of this joint convention in the matters recited above and to represent them and other organizations interested in wild bird and animal protection, and for the purpose of representing these several organizations in other congressional efforts that may be undertaken, looking for the further protection of our wild mammals and birds, there be and there is here created the "National Committee on Wild Life Legislation" consisting of eleven members to be selected as follows:

"One to be appointed by each of the following organizations: International Association of Game, Fish, and Conservation Commissioners; Western Association of State Game Commissioners; The American Forestry Association; American Game Protective Association; Izaak Walton League of America; and the National Association of Audubon Societies; and that this Committee so created shall have power to add to its number five additional members selected at large throughout the United States."

EIDER DUCKS BREEDING IN MAINE.—Contrary to the general belief, eider ducks do not breed exclusively in arctic and sub-arctic regions. Some years ago a breeding colony of them was discovered on the coast of Maine by an agent of the National Association of Audubon Societies. The Association at once employed a warden to guard the birds against the raids of local fishermen, who were reported to have a decided taste for their eggs. This protection has been continued every summer, with the result that the eider ducks are now holding their own as a breeding species within the borders of the United States.

SUMATRAN ORANG-UTAN THREATENED WITH EXTINCTION.—The preservation of the gorilla is assured in Africa, thanks to the work of Carl Akeley, through the establishment of the gorilla sanctuary in the Parc National Albert. The orang-utan, another of the great apes, is sorely in need of similar protection, for it is threatened with rapid extinction in Sumatra, particularly because it is more restricted in its distribution.

The demand from zoölogical gardens for living specimens is steady and lucrative, because the animals do not long survive captivity, and since the natives have found a way of catching the orang-tans alive, they are being exported in large numbers. Only drastic measures restricting the capture and export of the orang-utans can avert their rapid extermination. To this end the Society for the Preservation of the Fauna of the Empire is hoping to get the Dutch government to adopt such restrictive legislation.

MEETINGS OF SOCIETIES

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—The New York Meeting of the American Association for the Advancement of Science and Associated Societies will be held December 27, 1928, to January 2, 1929, inclusive, with the American Musuem as headquarters. President Henry Fairfield Osborn, Honorary Chairman Michael J. Pupin, and Secretary Sam F. Trelease are coöperating with the Washington office and the secretaries of sections and societies to make the meetings an outstanding scientific event, with a special program for Sunday, December 30. On the morning of this day excursions are planned for those interested in the several well-known scientific institutions in New York and its vicinity. In the afternoon the Association and its associated societies are to be the guests of an anonymous friend at a gift concert of the Philharmonic-Symphony Society. The evening will be devoted to attending the reception given to the scientists by the trustees of the Metropolitan Museum of Art.

The evening addresses and some of the afternoon addresses have been carefully selected by President Osborn for their general interest to scientists and laymen alike, and will be held each day in the large auditorium at the American Museum. Following each address there will be a reception especially to students and workers in the field covered by the address, with visits to the pertinent exhibition halls.

CONTRIBUTORS TO THIS ISSUE

ALFRED M. BAILEY, director of the Chicago Academy of Sciences, has always enjoyed bird photography as a hobby. In this connection he has worked in Canada, the Hawaiian Islands, the Bahamas, and most of the United States. For three years he was a representative of the Biological Survey in Alaska, and only recently returned from the Field Museum Abyssinian Expedition. The bird life of our West has always interested him, and in his "Feathered Water Babies of the Prairies" he tells of some of the vicissitudes of a bird photographer's life.

ALBERT E. BUTLER, preparator at the American Museum, accompanied by Clarence Rosenkranz, artist, was sent early in 1928 to India, Burma, British East Africa, and Angola, to collect accessories and make color sketches for the backgrounds of several mammal groups, the animals for which had been collected by Mr. Arthur S. Vernay and Col. J. C. Faunthorpe. Mr. Butler describes some of his experiences in "The Jungle-land of Burma."

MISS FRIDA DAVIDSON has been actively associated for many years with the Hudson Guild Settlement, that center of all good things to the children of the crowded Chelsea district of New York City. She has long been a leader also in the Sunday School of the New York Society for Ethical Culture. In both fields of activity she has been able to combine happily her appreciation of children on the one hand and of story and drama on the other. The children of the Sunday School have, under her direction, frequently portrayed re-interpretations of the Christmas stories in playlets or other programs, the sources of which are presented in her article "How Our Christmas Customs Came," in this issue of NATURAL HISTORY.

WILLIAM D. MATTHEW, Ph.D., author of "The Ape-Man of Java," may be said to be a born palæontologist and geologist, partly because his father, the late Dr. G. F. Matthew, was one of the most eminent of Canadian geologists. From boyhood William accompanied his father on his geological rambles around his native city of St. John, N.B. Doctor Matthew's earlier papers were on mineralogy and geology, and it was not until after he had taken his doctorate at Columbia under the geologist Kemp, that he came to the American Museum at the invitation of President Osborn and began to devote himself to vertebrate palæontology. Doctor Matthew has to his credit a long series of technical papers and monographs dealing chiefly with fossil mammals and with the mammalian faunas of the Western States, which have brought him many high honors, including an active membership in the Royal Society of Great Britain. His *Climate and Evolution* is the most famous of his less technical writings.

EDWIN PENGELLY, who tells us about "Fish and Fishermen of Cornwall" is well qualified to write about this industry since his family were formerly owners of a fishing fleet at Cornwall,

and Mr. Pengelly was engaged in the pilchard fisheries for about five or six years. He is now second officier on the S.S. "Minnewaska" of the Atlantic Transport Line.

HERBERT P. WHITLOCK, C.E., the author of "What Is a Gem?" has been curator of minerals and gems at the American Museum since 1914, and specializes in mathematical crystallography. His principal work is on calcite, in which connection he has published a Memoir entitled *Calcites of New York*, and a *Critical Discussion of Forms of Calcite*, as well as several Museum Bulletins on special occurrences of calcites.

CHESTER A. REEDS, Ph.D., who writes about "Storms and Storm Tracks" in this number of NATURAL HISTORY, lived as a boy on the prairies of Central Oklahoma, where he witnessed many a tornado, and often, with his brothers, was forced to seek refuge in the storm cellar of his home. Doctor Reeds is curator of geology and invertebrate palæontology, and observer in charge of the seismograph at the American Museum. He is a frequent contributor to NATURAL HISTORY MAGAZINE.

GEORGE C. VAILLANT, Ph.D., author of the first article in this issue of NATURAL HISTORY, received his archæological training at Harvard University, giving special attention to Mexico and Central America, where he carried on field studies for Harvard, Peabody Museum at Andover, Carnegie Institution, and the Boston Museum of Fine Arts. In 1927 he was appointed assistant curator of Mexican archæology at the American Museum.

MARGARET MEAD, Ph.D., assistant curator of ethnology of the Pacific Islands at the American Museum, is now on her way to Australia as Fellow of the Social Service Research Council, where she is expecting to make field studies among Melanesians. She is the author of *"Coming of Age in Samoa,"* a work based on her studies of Samoan girls and women during 1925–26 when the National Research Council granted her a fellowship for this purpose. Her article "Children in Samoa," in this issue of NATURAL HISTORY is based on her first-hand study of the subject.

NEW MEMBERS

SINCE the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum, making the total number 10,635.

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FIFTY-EIGHT years of public and scientific service have won for the American Museum of Natural History a position of recognized importance in the educational and scientific life of the nation and in the progress of civilization throughout the world. With every passing year the influence of the Museum widens, as is witnessed by the increasing number of visitors who daily enter its halls. Nearly two and a half million persons visited the Museum for study and recreation during 1927, an increase of 15 per cent over the preceding year, and all of these had access to the exhibition halls without the pay ment of any admission fee whatever.

The Museum's service to the schools has been greatly increased by the opening, last year, of the new School Service Building. Ten million contacts were made during 1927 with boys and girls in the public schools of New York and the vicinity alone. Inquiries from all over the United States, and even from many foreign countries are constantly coming to the School Service Department. Information is supplied to, and thousands of lantern slides are prepared at cost for distant educational institutions, and the American Museum, because of this and other phases of its work, can properly be considered not a local, but a national—even an international—institution. Through its loan collections, or "traveling museums," which are circulated locally, 495 schools were reached last year, and 1,722,433 pupils were directly reached. Nearly a million lantern slides were lent to the New York City schools, and 3,301 reels of the Museum's motion pictures were shown in 122 public schools and other educational institutions in Greater New York, reaching 1,123,704 children.

Lecture courses, some exclusively for members of the Museum and their children, and others for schools, colleges, and the general public, are delivered both at the Museum and at outside educational institutions.

For those interested in scientific research or study on natural history subjects, the Library, containing 115,000 volumes, is available, and for the accommodation of those who wish to use this storehouse of knowledge, an attractive reading room is provided.

Many publications, both popular and scientific, come from the Museum Press, which is housed within the Museum itself. In addition to NATURAL HISTORY, the journal of the Museum, the popular publications include many handbooks, which deal with subjects illustrated by the collections, and guide leaflets, which describe individual exhibits or series of exhibits that are of especial interest or importance. These are all available at purely nominal cost to anyone who cares for them.

The scientific publications of the Museum, based on its explorations and the study of its collections, comprise the *Memoirs*, devoted to monographs requiring large or fine illustrations and exhaustive treatment: the *Bulletin*, issued in octavo form since 1881, dealing with the scientific activities of the departments, aside from Anthropology; the *Anthropological Papers*, which record the work of the Department of Anthropology; and *Novitates*, which are devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters. The Librarian of the Museum, who may be addressed in care of the Museum, may be called upon for detailed lists of both the popular and the scientific publications with their prices.

Expeditions from the American Museum are constantly in the field, gathering information in many odd corners of the world. During 1927 thirty-three expeditions visited scores of different spots in North, South, and Central America, Asia, Africa, and Polynesia, and nearly as many are now in the field continuing last year's work or beginning new studies.

From these adventuring scientists, as well as from other members of the Museum staff and from observers and scientists connected with other institutions, NATURAL HISTORY MAGAZINE obtains the articles that it publishes. Thus it is able to present to the constantly enlarging membership of the American Museum the most fascinating and dramatic of the facts that are being added to the Museum's knowledge, or are deposited in this great institution.

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